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WORLD CROPS

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Editorial Comment

The Imperial College of Tropical Agriculture

THE celebration last month by the Imperial College of Tropical Agriculture in Trinidad of the silver jubilee of its Royal Charter was an event of more than passing interest.

Founded originally in 1921 as the West African Agricultural College, its scope was extended in 1924 to include agriculture in all its forms throughout the tropics, when its title was changed to that which it now bears, the seal being set on this development by the grant of its Royal Charter two years later.

In a recent article in *The Times*, Sir Raymond Priestley the present Chairman of the Governing Body reviewed its history and achievements during the past 25 years and discussed the part it is expected to play in the future.

Nobody with a knowledge of the history of the College and the events which led to its establishment will gainsay that it has more than amply fulfilled the hopes and expectations of those who were responsible for its inception, nor that probably more than any other single institution it has profoundly influenced the development of agriculture not only in tropical colonial territories which it was primarily designed to assist, but also throughout the whole tropical world.

Past students of the College now fill the majority of the senior posts in colonial agricultural departments and agricultural research institutions, while many others occupy important posts in Commonwealth and foreign tropical countries outside the colonial sphere. Its record of research is impressive, especially bearing in mind the slenderness of the resources which it has been able to command during the greater part of its history. Moreover, as Sir Raymond Priestley points out, the College has never ceased its original task of training West Indian citizens for agricultural pursuits. Truly an impressive record.

It is of interest to recall that the College was originally started when the Imperial Department of Agriculture for the West Indies—inaugurated in 1899 as the result of the recommendation of the West Indies Royal Commission of 1897—ceased to exist as the result of the termination of the grant in aid by H.M. Government. The idea for its inception came from the late Sir Francis Watts, then Commissioner in charge of the Department and afterwards first Principal of the College. The Imperial Department was the prototype and forerunner of the numerous colonial departments of agriculture which exist today. The development of the College to its present role as a Commonwealth centre of training and research owes much to the late Lord Milner, who conceived the idea and, as first Chairman of the 1927 Committee on Agricultural Research in the Colonies, did much to further it.

It follows that the present position of the College is the result of gradual but more or less continuous evolution for a period of over 50 years.

It is a matter for satisfaction that the greatly extended resources now available to the College have permitted a great enlargement of its training and research facilities; unfortunately the rising cost of living still gives cause for anxieties in regard to expenditure.

In years to come, as Sir Raymond Priestley says, the quality of its teaching and research should continue steadily to extend and improve, and it may well be that, if political wisdom prevails, its golden jubilee will see it occupying a still more important position than it does at present.

New ideas on soil science

ON another page we publish the first part of an article by Mr. D. P. Hopkins entitled 'New Ideas on Soil Fertility.'

Soil science, no less than soils themselves, can suffer from too much monoculture. To assume that each advance in knowledge will spring from the planned extension of old and existing theories is a prejudice no less reactionary because it is unconscious. The investigation of new ideas, like the cultivation of new soils, may sometimes produce greater returns for the same effort.

It must be counted an advance that the texture of current thought has a greater absorption capacity for new ideas than formerly. On the other hand, what might be called the physical or mechanical climate for developing new ideas is less favourable. The major proportion of research is state-controlled; inevitably (or so it seems) research programmes are rigidly planned, often for some years ahead, and grievously little room is left for deviations. Add to this the fact that most soil investigations require one or two growing seasons to yield results and it is clear that a new idea, however promising, is likely to face a long session in the waiting rooms of organised research.

Nor is the rigid pre-planning of research the only delaying factor. The ever-swelling flood of research literature is another. Year by year the chance that one particular research paper or research note will be widely noticed becomes smaller. The new idea is probably more seriously

handicapped than the advance that is a natural extension of older ideas; for the latter can be tidily classified in its appropriate section of abstracts while the former may have to take an ' odd-man-out ' position. Also the practical value of a new idea may lie in a field far distant from that in which it first emerges; the greater the flood of research literature the more difficult it is for idea A in one country to be connected with problem B in another.

There are certainly ways by which the problem of focusing attention upon new ideas or conceptions can be eased. Journals of soil and agricultural science should pursue a liberal editorial policy, one that swings ' left ' rather than ' right ' from the orthodox centre. There might, too, be some re-definition of research in soil science. It can hardly be denied that many papers are no more than reports of routine investigations of this or that ' soil-crop-climate ' association using the standard plot-test technique. Is not this in effect routine work, and unless some new type of result emerges, or some new technique or approach has been attempted, is it not time to classify it as such? At present there is no differentiation in abstracted accounts between the one type of research paper and the other.

A third method lies in occasional and independent surveys of the literature by readers who have the time and opportunities to do so; their selection of items must be personal rather than exhaustive, and possibly some of the swans they point to will in the end turn out to be only wild geese. In more than one crowded branch of science there are signs that technical journals are increasingly providing opportunities for surveys of progress. WORLD CROPS, since its beginning, has been no exception. By all these means the chance that a new idea will be lost or, worse still, fade away for lack of nutrition, can be appreciably reduced.

Land tenure and co-operation

ALTHOUGH there is ample evidence that new techniques including mechanisation can greatly increase production, their introduction to an incorporation with peasant agricultural systems raises difficult problems. This question has been discussed in a number of articles which have appeared in this journal, but in relation to rice cultivation it is especially perplexing, and it seems to us doubtful whether up to the present sufficient account has been taken of this in connection with projects in the Colombo plan.

When it is a question of settling peasantry on newly-opened irrigated lands, the problem is simpler, as is shown by the great cotton developments in the Gezirah of the Anglo-Egyptian Sudan or by the French scheme in the Niger Bend, the latter described in the article in this issue by M. Maurice Rossin.

Even here, however, the conditions of settlement and terms of occupation require most careful consideration and research, for on them the success or failure of the enterprise largely depends.

When, however, it is a question of introducing new and revolutionary methods among established peasant rice-growing communities steeped in the traditions and practices of the past, the task becomes peculiarly difficult. It is obvious that these lands must continue to be occupied, for in many cases they are highly fertile and in some irrigation already exists; on the other hand, the conditions which prevail are oft-times most inimical to progress.

An indication of the difficulties is given in an article by Mr. C. S. W. Hartley in this issue which describes the conditions among existing peasant rice-growing communities in Malaya. The difficulties include uneconomically-sized and excessively-fragmented holdings (the results of unsatisfactory inheritance customs), unsatisfactory labour conditions, indebtedness and so forth. Population pressure in many of them is excessive and there is not full employment. If the position is to be improved the remedies may have to include transfer of part of the population and their resettlement elsewhere. To get over the complications due to existing tenancy conditions, nationalisation of the land and state leases to cultivators may ultimately prove to be the only effective remedy. Under such conditions as they stand, mechanisation and improvement of agricultural practices is almost impossible.

Indian aspects

THAT picture refers, it is true, to Malaya, but it has found its replica with local modifications in many other Eastern countries. A book recently reviewed in these columns and entitled ' The Problems of Zamindari and Land Tenancy ' by Prof. P. M. Driver, of Poona, discussed the matter in its Indian setting. He, too, arrived at the conclusion that the only practicable solution is land nationalisation and the operation of consolidated small holdings on a group farming co-operative basis. Incidentally, he pointed out that in India and, it might be added, in most other parts of the British Commonwealth, the co-operative principle has found its application in agriculture almost entirely in finance, marketing and the purchase of supplies. He pleads for the extension of co-operation to the actual conduct of farming operations and cites the example of the collective farms in the Soviet Union, from which he urges many lessons could be learnt.

He suggests that these should not be condemned out of hand because they are, so to say, tarred with the Communist brush. In their present form they embody much of the co-operative principle. It is true that they are a compromise adopted when the

original Soviet plan for the complete state operation of Russian agriculture broke down and are regarded merely as a makeshift compromise by the Communist idealists who continue to hold that when the Communist Utopia finally materialises they will disappear. It does not, however, alter the fact that the collective farms in Russia appear to be working with fair efficiency, and although one must take all that comes from behind the Iron Curtain with reserve, there is evidence that the introduction of the same system in Bulgaria is producing very satisfactory and striking results.

May it not be, therefore, that the nationalisation and collectivisation of holdings on co-operative lines holds the germ of the real solution of this particularly difficult problem ?

Systemic insecticides and fungicides

FEW developments in the application of research to agricultural practice have had a greater appeal to the popular imagination than the systemic insecticides of which so much has been heard. The idea that by applying a chemical to the roots or some aerial part of a crop plant, or by injecting it into its tissues it is possible to convey resistance to its insect enemies without harming the plant itself, affecting the usability of the produce, or harming the parasites which attack the insects, is one which must perforce conjure up visions of almost boundless applications in the future. It is, in some respects, the parallel in the realm of plant hygiene to some of the vast developments which have occurred in human and animal pathology; for example, the use of quinine, atebrin and, most recently, paludrin in malarial prophylaxis and treatment. In both cases the protective substance is translocated within the organism, in the case of vertebrate animals in the blood stream and in the case of plants in the sap stream. Indeed, many will wonder how it is that advances in the realm of plant physiology have lagged so far behind those in animal physiology.

There are, however, a number of important differences; for one thing, in animals by reason of the heart's action, the blood stream circulates rapidly, and for another the relatively high and uniform temperature of the blood stream favours rapid and uniform action of the injected material. In the case of plants, movements of the sap stream are mainly brought about by osmosis and are much slower, while the temperature varies with that of the surrounding environment.

The earliest examples of systemic insecticides are compounds of selenium, but these render plants poisonous to humans and livestock and their use has not been further developed so far. At present attention is largely concentrated on the phosphorus-organic compounds first developed as insecticides by Schrader in Germany during the war, the selective systemic action of certain of which has recently been applied commercially by Ripper and his co-workers in Pest Control Ltd. These products have been described and discussed in recent articles in WORLD CROPS, the latest of which appeared in our April issue. Doubtless many other forms of selective systemic insecticides will appear in due course.

A point of importance which is beginning to emerge is that substances absorbed by plants probably do not always remain unchanged in the sap stream but may undergo changes in it or influence growth and development of the plant itself. Thus, one of the newest phosphorus insecticides (provisionally named Isopestox) develops selective action only after it has been absorbed and translocated by the plant.

Another point is that even inert materials such as petroleum may be absorbed and translocated in the sap stream without damage provided their physical condition is right, a point brought out in an article by Dr. E. R. de Ong in our January issue.

The most recent development is the possibility of the application of the systemic principle in fungicides. The pioneer in this matter is Dr. J. G. Horsfall of the Connecticut Experiment Station. This aspect was reviewed in two recent papers read before the Crop Protection Panel of the Agriculture Group of the Society of Chemical Industry by Prof. R. L. Wain of Wye Agricultural College and Dr. R. W. Marsh of Long Ashton Experiment Station. Prof. Wain discussed, *inter alia*, certain aryl-oxy-alkyl-carboxylic acids which may be translocated within the plant and exercise systemic fungicidal action, while Dr. Marsh referred to the control of wilt-inducing pathogens by systemic fungicides such as dithiocarbamates, chlordimethyl-phenoxy-ethanol, and norcamphanemethanol. Research on all these is in active progress and the subject is still in its infancy. Dr. Marsh was careful to emphasise that too much importance must not be attached to the practical aspects of it at present. Nevertheless the intriguing nature of the possibilities is self-apparent, and who knows what great advances the future may not hold in store?

The improvement of rice yields

WE have, in these columns, referred to the rice industry on many occasions, but the subject is of such colossal importance to the peace and prosperity of the world that we make no apology for reverting to it.

Rice is the staff of life in many eastern lands and the effects of the war have been acutely felt in reduced supplies. It is true that during the past year or so increased supplies of imported wheat and coarse grains have partially compensated for rice shortages, but this does not alter the fact that the

traditional food of the East is mainly rice and is almost certain to remain so. With the exception of Siam, production in the two other main exporting countries of the Asiatic rice bowl, Indo-China and Burma, remains far below the pre-war level owing to unsettled political conditions. India, Pakistan and Japan have, it is true, considerably increased their output, but as these were always importing countries it has only served partially to compensate for the deficiency. In addition populations have increased since the war by at least 10%, all of which serves to increase the effect of the shortages.

It is not to be wondered at, therefore, that great efforts are being concentrated on increasing rice production and that a large proportion of the proposed agricultural expenditure under the Colombo plan should be devoted to that end.

Rice yields in the majority of the tropical Eastern countries are on the average low, amounting to less than one ton of rough rice to the acre. On the other hand, in the sub-tropical or semi-temperate countries where rice is grown they are considerably higher; thus in Japan they average 1.75 tons, in the U.S.A. well over 1 ton and in Australia, Italy and Spain over 2 tons. It has been suggested that the difference may, in part, be due to the greater day length in these higher and lower latitudes during the growing season, which favours higher yields, but there is also no doubt that important contributory factors have been improved varieties, better cultivation, efficient water control and manuring. Indeed there is abundant experimental evidence that much higher yields can be obtained in tropical latitudes by attention to these factors.

Rice cultivation by the traditional Eastern methods is laborious and exacting; most of the work is done by hand with the assistance in some cases of primitive ox- or buffalo-drawn implements. In the U.S.A. and in Australia, on the other hand, the industry is wholly mechanised. Naturally more attention is being paid to mechanisation as a means of increasing production in tropical rice-growing areas.

Extensive experiments have been in progress for some years in Malaya as well as in British Guiana, and the results are encouraging. We have already published an account of recent work in British Guiana and hope to include before long an article on the Malayan work, while an account of experience in the same connection in French West Africa appears on another page of this issue.

In answer to a parliamentary question recently, Mr. J. Griffiths informed the House of Commons that proposals are under consideration for the extension of rice production in British Guiana under the aegis of the Colonial Development Corporation and the British Guiana Government. We understand that these envisage the great extension of mechanised cultivation based on the results of the earlier experiments and that the proposals are at present being examined on the spot by an expert working party appointed by the C.D.C.

It seems certain that other similar and larger scale proposals will in due course make their appearance in connection with the Colombo plan, for which it is interesting to note that there are encouraging signs that the necessary finance is likely to be forthcoming from various quarters.

Farm prices in Britain

AS is to be expected the review of farm prices announced by the Minister of Agriculture on March 29 last has given rise to much discussion and many criticisms.

The review represents a marked change in the emphasis of Government policy compared with previous years. In the Government's view the main emphasis must now be placed on meat, a decision primarily dictated by the shortages from the Government's failure to come to terms with producers in the Argentine; this is reflected in higher price increases for fat stock. On the other hand, it is held that the inducements previously given to milk production can be relaxed; indeed in many quarters it is considered that stimulation of milk production may have been overdone.

The main criticism is that the price increases which steeply rising living costs necessitate, do not compensate for the actual increases in the costs of production. In particular it is urged that specialist dairy farmers, who must continue production in any case, have received increases which are quite inadequate. The findings have been accepted by the various farmers' unions but only after prolonged discussions in the course of which the Government's offers were appreciably raised; even so, considerable dissatisfaction exists, and it is considered in many quarters that the farming industry has been dealt a severe blow at a time when it is suffering from the effects of the worst season in living memory.

The Government have stated that they shortly will issue a White Paper on farm costs and farm prices and this should help to clarify the issue. The fact remains, however, that British agriculture will have to face a difficult time particularly having regard to the unpropitious weather conditions, which at the time of writing unfortunately show no marked signs of improving.

THIS MONTH'S COVER

Rice cultivation in the northern delta area of Egypt. A scene which finds its replica in the millions of acres cultivated in rice throughout the East and strikingly illustrates the exacting nature of the cultivation of this cereal by traditional Eastern methods. *(Photo: Caterpillar Tractor Co.)*

A view of the Sansanding dam from the upstream side

Agricultural Development in the Niger Bend

The Sansanding Scheme in French West Africa

MAURICE ROSSIN

Secrétaire Général de l'Office de la Recherche Scientific Outre-Mer

In view of the great and growing interest that attaches to schemes for agricultural development in backward territories in the tropics, this account of the French scheme for development in the Niger Bend in French West Africa will be welcome. It has a resemblance to the Gezirah scheme in the Anglo-Egyptian Sudan.

EQUATORIAL Africa was, until comparatively recently, segregated from the major developments in tropical agriculture which have been so prominent in other parts of the tropics. Its low population density, its harsh and oft-times capricious climate and its great size, have combined to make penetration more than ordinarily difficult. Of recent years, however, and particularly since the end of the second world war, much more attention has been paid to the need for developing the vast territories of French West Africa which lie, so to say, at the very gates of Europe, and it is now apparent that their development is not only possible but urgently necessary.

Agricultural improvement is, of course, the first and most pressing question. One reason why development has been so slow is the difficult combinations presented by natural conditions. In some places soils are fertile but rainfall is insufficient; in others there is abundance of water but soils are poor. In others again, both fertile soils and plenty of water exist but owing to one cause or another populations are scanty. Intense agricultural development in Africa necessitates the amelioration of natural conditions by human agency and this can only be achieved by considerable effort and with the aid of adequate financial provision.

The bend of the River Niger, where rich alluvial soils exist but rainfall is deficient while population is sparse and scattered, provides an example of development of this description.

Conditions in the Niger Bend

The Niger rises in the Futa Jallon mountains in French Guinea, which lie only a few hundred miles from the coast; from there it runs north-east, flowing through the mountains of High Guinea and receiving many tributaries that drain that vast area, which has a natural precipitation often reaching 40 in. As far as Bamako, the capital of the French Sudan, the river traverses a series of smallish alluvial plains lying between the banks of the river and the sandstone or lateritic hills nearby. They are individually only a few thousand acres in extent and mainly used for scattered rice cultivation. The area cultivated each year and the yields obtained are closely related to the magnitude of the annual floods of the river which inundate these plains.

During past years a number of small regulating works have been constructed, mainly on the small tributaries of the river which flow through these plains, and these have progressively helped to reduce the uncertainties of the annual floods and allowed more regular crops to be obtained; in consequence, the difficulties of food production in the area have been lessened.

In the neighbourhood of Bamako a series of rapids extends for about 20 miles along the course of the Niger, after which the river becomes less turbulent and flows through a series of much more extensive plains, while 200 miles downstream from Bamako it reaches a vast level area through which it flows for the next 300 miles. This area is termed the Central Delta of the Niger; in it the average slope of the land is only about 3 in. per mile.

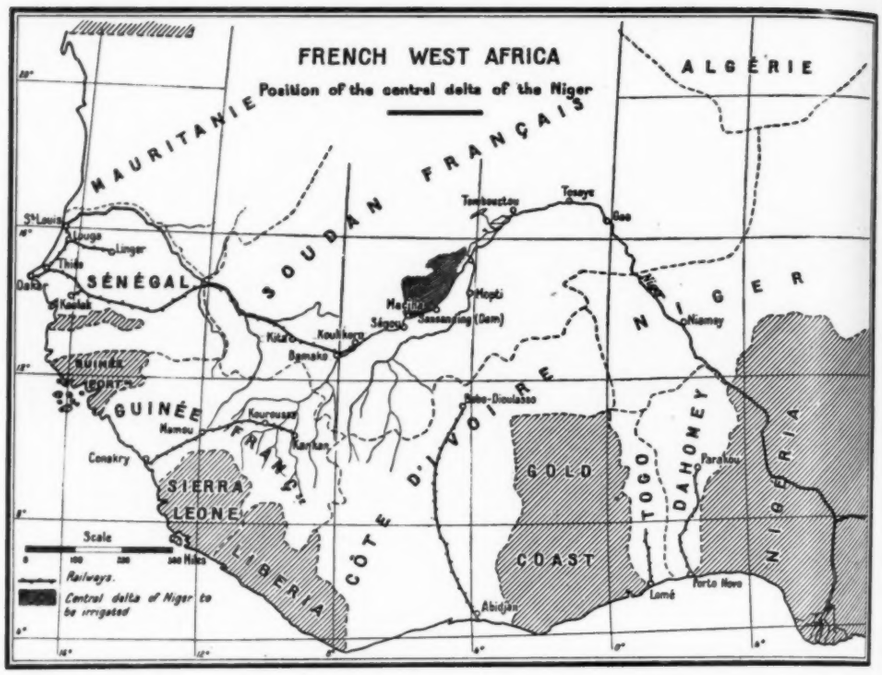
Origin of the Central Delta

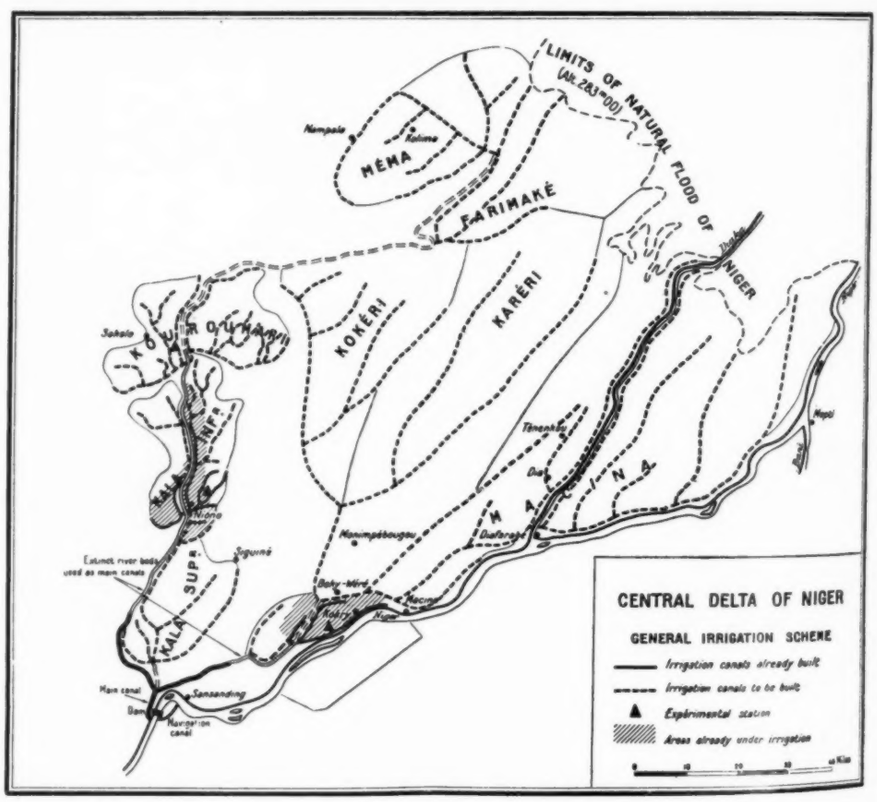
In geological times the Niger flowed towards the north-east but found no outlet to the sea, its waters being discharged into a very large inland lake lying somewhere between Sansanding and Timbuctu. With the lapse of years this lake became gradually filled with silt transported by the river. At that time the part of the Niger that runs from the north-west to the south-east, traverses Nigeria and finally debouches into the Gulf of Guinea, was separate from the north-eastern section. As a result of gradual erosion the sill at Tosaye was gradually worn through and the high Niger joined the lower section and found its way to the sea, while the inland lake was able to empty itself; as a result vast areas of alluvial land then appeared.

Development of the project

On this land about 25 years ago studies were commenced for the development of a vast project of agricultural improvement under the auspices of a public body set up for the purpose, entitled L'Office du Niger.

The soils in this vast area are of the heavy alluvial type and contain some 60 to 85% of silt and clay, the proportion of clay in them increasing as the distance from the river increases. The rainfall is low; at Sansanding itself it amounts to 20 to 25 in. —falling between mid-June and the end of September—but in the more northerly parts of the Delta it falls as low as 10 in. per annum or less, an amount insufficient to allow agricultural development. On this account the population of the area was extremely low, amounting to only one or two per square mile and consisting mainly of nomadic pasturalists. Cultivation was concentrated on narrow strips of land close to the river and its tributaries, which were annually flooded with the rise of the river and permitted the cultivation of wet rice; crops were, however, very uncertain owing to the variability of the floods. The natural conditions were, in fact, very similar to those which existed in the Gezirah of the Anglo-Egyptian Sudan before the construction of the Sennar Dam on the Blue Nile.



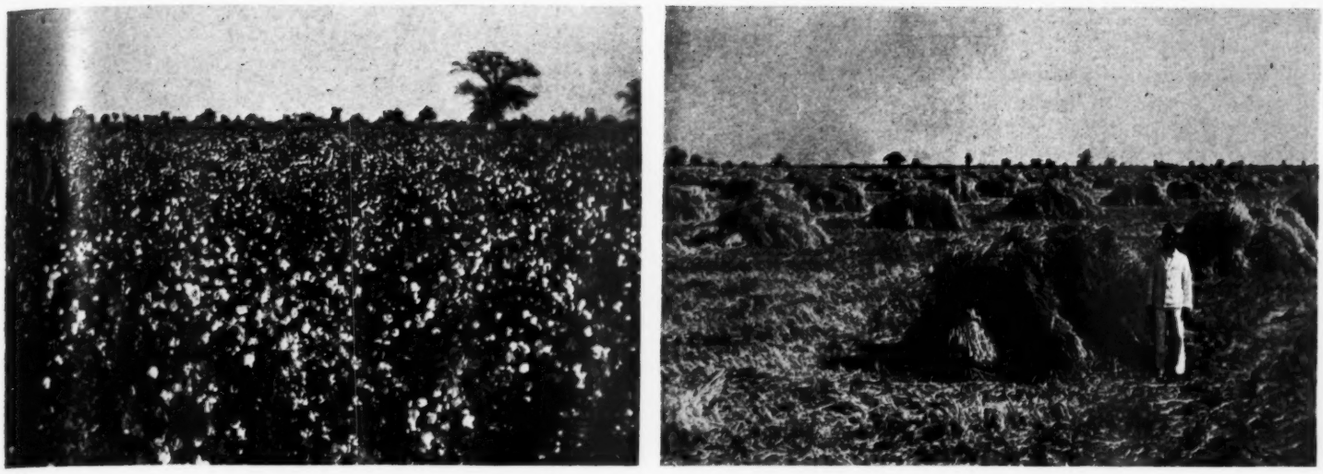


Form of development

The fact that agricultural development hinged on water supplies naturally led to concentration on a large-scale irrigation project in the neighbourhood of Sansanding. There the bed of the Niger is at a higher level than the land through which it flows and this in itself afforded conditions favourable to irrigation. Accordingly the main objects of the scheme that was devised fell under the following headings: (a) the construction at the head of the central Delta of a dam spanning the Niger which would permit by means of sluices the maintenance of the level of the river at a sufficient height to allow some 2,500,000 acres to be irrigated by gravity, and (b) the construction of a main canal with its head upstream from the dam to carry the water inland and to base upon this a network of distributary canals which would bring water to all parts of the area to be irrigated.

The project was one of considerable difficulty, as the area is nearly a thousand miles from the coast and development involved considerable problems in matters of transport and supply.

On the other hand the scheme had the advantage that in demarcating lines for the main irrigation canals it was possible to utilise to some extent the old beds of the



Crops in the central delta. (*Left*) **A cotton field and** (*right*) **a rice field just harvested**

Niger river which had become dry when the river assumed its present course. This enabled considerable savings to be made in excavation. A further advantage was that it was possible to take sufficient water from the Niger without markedly altering its rate of flow nor reducing the amounts of water which would be available to communities in the lower reaches; the reason for this being that the very wide area over which the river flowed before development was begun caused evaporation to be intense, especially in the so-called flood area downstream from Moctam. The total area that it was proposed to irrigate was 1,000,000 acres of which 250,000 would be under cotton, 250,000 under rice and the remainder occupied with rotation. The quantity of water needed to irrigate this was assumed to be 300,000 million cubic metres per year, which is about 5% of the annual flow, and it was judged that this is far less than the quantity of water which evaporated in the flood area under uncontrolled conditions; this economy would be achieved by narrowing the breadth of the river by means of embankments in the divergation area, thereby lessening the surface exposed and consequently reducing evaporation.

Type of development envisaged

From the outset the principle has been observed that development would be brought about not as a capitalist enterprise but by colonisation of the area by Africans who would be settled on the land on demarcated plots, the size of which would be determined by the resources each settler could command. Development would be guided by a group of competent technicians whose task it would be also to educate cultivators. For operational purposes the African colonists would be organised in groups, while the whole scheme would be operated on co-operative principles. The effect would be to maintain the social advantages of individual farming combined with the benefits derivable from operating as a single unit.

In practice each family is assigned a plot of land, the size of which is determined by individual circumstances. The plots are laid out for irrigated cultivation prior to occupation. Each plot has the characteristics of a private property, with the reservation that it is not possible for occupiers to dispose of their holdings. Such a precaution is necessary in order to avoid dangers from speculation or from undesirable fragmentation. Under the scheme each tenant occupies his own plot, owns his livestock, carries out normal cultural operations and reaps his own produce. The heavier work such as deep ploughing and preparation is carried out for him by the undertaking as a whole which is also responsible for maintenance of the irrigation system and distribution of water; it also undertakes marketing of the crops.

Preliminary investigations

As there was little or no previous experience to serve as a guide, a great deal of preliminary investigation had to be carried out before a start could be made with the full-scale project. This included:

(1) Topographical studies and surveys which had to be carried out under very difficult conditions. During the course of them more than 10,000 square miles were accurately surveyed. This was a necessary preliminary to laying out the irrigation network.

(2) Agricultural investigations. These were performed at a number of experimental stations, the object being to introduce or evolve by selection varieties of crop suited to the natural conditions and to study their cultural requirements.

(3) Soil investigations. These go hand in hand with topographical surveys and provide essential indications of the agricultural potentialities.

(4) Technical studies to determine the best way to carry out the irrigation works and distributories.

(5) and (6) Economic and sociological investigations designed on the one hand to ascertain the economics underlying the cultivation of the crops and to determine the conditions under which land would be leased; and on the other hand, to gain knowledge of the social circumstances and traditions of the African which will facilitate bringing about the contemplated revolution in his customary methods of work.

This programme involved a vast amount of work which has been in progress during the past 25 years. The period 1925-34 was devoted entirely to these main general studies and to the setting up of small communities to test the colonisation plans. The diversion dam at Sansanding was begun in 1934, while construction of the tributary canals was commenced shortly afterwards. In 1935 the work was sufficiently far advanced to enable a start to be made with the first settlement of African cultivators. Settlement proceeded during the following years but unfortunately the outbreak of war in 1939 greatly delayed development. The completion of the Sansanding dam which had been originally scheduled for 1941 had to be postponed and it was not until 1947 that it was actually finished and put into operation. The delay in completing this essential work which was the key of the whole scheme jeopardised the colonisation that had already been begun. By the beginning of 1945, however, it was possible to resume the building of the dam and at the same time to proceed with the consolidation of African colonisation that had

already been established. It is only since 1949 that the essential works have been finally completed and the colonisation consolidated. It can now be said that the different aspects of the problem have been elucidated, the human and material elements of the scheme have been assembled and the scheme fully launched on what it is hoped will prove to be a career of rapid development.

The present position

The Sansanding dam was, as stated above, finished in 1947. It comprises a masonry dam spanning the Niger about 2,500 ft. long with movable sluice gates, which is completed by further earth dams on either side, the total length of which is 6,000 ft. A navigation canal with a lock has been constructed on the right bank of the river so as to permit navigation to be continued.

The main irrigation canal starts upstream from the dam. It is 170 ft. wide at the bottom and five miles in length. At its end it sub-divides into two canals each 85 ft. wide at the bottom and provided with sluices and locks at the point of diversion. These canals were dug for 14 miles after which they reach two disused channels of the Niger, which after embankment can also be used as distributors. From these the distributory canals take off.

In the construction of the dams 106,000 cubic metres of masonry and concrete, 9,000 tons of steel, 50,000 cubic metres of rock and 750,000 cubic metres of earthwork were employed.

In the first stage, 55,000 acres of land have been cleared and provided with irrigation canals. On this area 20,000 African colonists have been settled, the settlements being divided into 64 villages which were constructed before the settlers arrived. The settlers own between them about 20,000 head of cattle and more than 3,000 individual ploughs.

Co-operative associations have been set up to which all settlers must adhere, and these own a large quantity of farming implements including 70 tractors of varying power, a modern ginning factory, three rice mills and a large amount of miscellaneous equipment including vehicles, boats and so on. The annual production from this first development has, on the average, been as follows: 30,000 to 35,000 tons of foodstuffs including 25,000 tons of paddy, 1,500 tons of unginned cotton and 500 to 600 tons of groundnuts; the average outputs per acre were approximately 2,000 lb. of paddy and 1,000 lb. of unginned cotton.

After deducting amounts used by the settlers themselves or sold direct to local consumers, the value of the produce sold so far is estimated to be £500,000, of which something over £100,000 represents charges that have to be supported by the settlers, *e.g.* for the use of water, overhead costs and costs of processing and marketing the crops.

Digging one of the major canals with an elevating digger

Future prospects

Obviously if this represented the sum total of achievement it would be insignificant, but actually it is only a beginning, and development is now proceeding at the rate of 10,000 to 15,000 additional acres per year. It is estimated that by the end of ten years from 1949 the scheme will increase to a total of 120,000 acres, while it is anticipated that improvements in working conditions and additional knowledge should make it possible to realise yields of over 3,000 lb. of paddy and more than 4,000 lb. of ginned cotton per acre. On a longer term it is estimated that it will be technically possible to develop a total area of 1,500,000 to 2,500,000 acres.

These developments represent the outlay of considerable amounts of capital and the possibilities are naturally conditioned by the ability to continue to reap crops which will cover the cost of cultivation and the heavy initial capital charges. The developments are situated in the heart of French West Africa and are thus strategically placed. They are of vital importance in providing additional food for the inhabitants of the coastal territories such as Senegal, Guinea and the Ivory Coast, which territories being mainly devoted to the cultivation of export crops would derive from the scheme of the Niger Bend essential and vital food supplies. The task is long, arduous and expensive; the difficulties, however, are fully realised, while the potentialities are clearly indicated. A high priority must, therefore, be given to this development since it is only by the utilisation of modern techniques that the maximum production rendered possible by natural conditions can be achieved.

Ceylon Coconut Quarterly

We have received a copy of the *Ceylon Coconut Quarterly*, a new journal published by the Coconut Research Scheme in Ceylon. It is, so far as we know, the only publication in existence devoted exclusively to the coconut crop and, on this account, it seems to fill a definite want. The copy we have received contains a number of interesting articles relating to coconut cultivation and copra manufacture. Of especial interest are articles on ' Grass and the Coconut,' by Dr. McLagen Gorrie, and one on ' The Effect of Illuk Grass on Coconuts.'

The Coconut Research Scheme has now been in existence for over 20 years. The former director, Dr. R. C. Childs, recently left Ceylon to take up a post at the new Tea Research Centre in East Africa. He was succeeded last year by the present director, Mr. F. C. Cooke, who has had wide experience of coconut problems in Malaya.

It will be remembered that an article on the coconut industry of Ceylon, from the pen of Dr. Childs, appeared in the issue of this journal for March 1950.

The headquarters of the Ceylon Coconut Research Scheme are at Bandiruppuwa Estate, Ceylon.

Establishment of New Rice Areas in Malaya

C. W. S. HARTLEY, B.A., Dip. Agr. (Cantab.)

Increased rice production in the East is a major problem of world agriculture; a large proportion of the expenditure proposed under the Colombo plan will be devoted to this. The problem is a complex one, considerably affected by existing conditions among the peasant growers, and any attempts at development must take them into account. This article, which discusses these aspects as they occur in Malaya, provides an indication of the type of difficulty that has to be faced and overcome if rice production is to be increased. The author was until recently a senior agricultural officer in Malaya.

RICE is the staple food of the vast populations of Asia. Production outside Asia is confined to some comparatively small peasant areas and to the capitalist and mechanised areas of the United States, Australia and elsewhere. The latter have given much useful information on mechanisation and cultivation generally, but their two million acres account for only a small fraction of the world's total supply.

In Asia populations are increasing faster than anywhere else. Present rates of increase vary from 1.3 to 2.4% per annum. In the main rice-growing areas of South-East Asia an increase of population of at least 150,000,000 is expected in the next 20 years. But already in most of this region agriculture is employing up to 80% of the people and pressure of population is causing widespread under-employment. In Ceylon 1,200 people depend on agriculture for every 1,000 acres cultivated, while in Great Britain the corresponding figure is only 60. Another recently quoted comparison is that between the 306,000,000 acres cultivated by 73,000,000 workers in India and the 360,000,000 acres cultivated by only 8,000,000 workers in the United States.

Two-fold problem

It can be seen therefore that the problem in Asia is two-fold. Firstly, there is the necessity of finding and bringing into production new areas to provide rice for the increasing populations. Secondly, there is the more difficult and ultimately more important problem of eliminating under-employment and raising production per man. One of the disappointments of the recent Colombo Plan is that while the second problem is stated it is only to the first problem that suggestions and recommendations are directed. It is pointed out in the report that the resources of man-power and of land are large enough to provide food for the increasing populations, and for this large capital sums are required. No consideration is, however, given in the report to the re-organisation of existing paddy areas or to the organisation of the new ones to be created so as to ensure that production per man is increased and maintained. Possibly this omission is due to the belief that the problem is largely political and that each country must solve it for itself. It is none the less fundamental and if it is not solved new schemes must ultimately fail in their objective.

In this article this problem is discussed in its application to Malaya, a country which differs from other countries in Asia in that an exceptionally large proportion of the population is engaged in the export industries of rubber and tin production. Before the war two thirds of the rice consumed was imported. Since the war a rather higher proportion has been home grown owing to reduced consumption per head and to an increase in the area cultivated to not far short of a million acres. Almost all the rice crop is grown by a native peasantry, the Malays, and in spite of the different economic structure of the country the problems of the rice areas are essentially the same as those of other rice-growing countries.

Mechanical cultivation of padi. Disc harrowing in a flooded field, using special wide wheels

Objectives of expansion

Let us begin by considering the human side and ask what exactly a Malay will require to induce him to leave old areas and start cultivation in new ones opened from jungle or scrub? It must be remembered that he has no capital and that therefore he must be provided with (1) the means of

subsistence until his first crop is in, and (2) buildings, implements and livestock for his holding. Some of the building can, it is true, be done by himself from jungle materials obtained during felling, while much of his subsistence can be earned by the work of felling and burning the jungle on the area allotted to him as well as on areas required for roads, canals, schools, etc., but adequate provision in both respects is a prime need. Malays are accustomed to live in *kampong* areas surrounding the padi lands. These consist of small orchard holdings, of ¼ acre upwards, on which the cultivator has his house and which also provides him with fruit, vegetables and eggs, and on which he houses his cattle, buffaloes, goats and poultry. The *kampong* area is thus an essential part of permanent peasant settlements in rice growing regions; it must not be regarded as a matter of minor importance in the establishment of new areas. The cultivator needs to have a *kampong* holding which will be 'tied' to his padi holding and in which he can plant fruit trees and perhaps rubber, coconuts or some other cash crop so that his agriculture may be stable and balanced and his time occupied productively throughout the year.

In the past in Malaya new padi areas have often started with merely the opening up of the padi lands; it is true that reserves have usually been ear-marked for *kampongs*, but often their size and location have received insufficient attention. It is the writer's belief that in opening new padi areas one of the main objects should be to provide a balanced agricultural system from the start; sufficient facilities and capital should be provided for the efficient opening and stocking of the *kampong* areas as well as the rice areas. *Kampong* lots will necessarily vary in size according to the area available, but they should not be less than two acres while anything over 10 acres is likely to become unmanageable by one family.

The reasonable requirements of the prospective settler have been put first because no scheme is likely to be really successful unless these are met. The main object of new schemes is, of course, the production of the maximum amount of rice surplus to the requirements of the area itself; for if the settlers merely produce enough rice to feed themselves little is gained. The acreage cultivated per family must therefore be the maximum possible with the tools in use, and this point will be discussed in greater detail later.

An additional objective in opening new padi areas is the reduction of overcrowding and under-employment in the existing areas, and before proceeding to consider the establishment of new areas it is desirable, therefore, to examine conditions in the old areas.

Conditions in established areas

No surveys of ownership, tenancy or land utilisation have so far been made in Malayan padi areas, and it is therefore impossible to say exactly how overcrowded they are. Surveys are indeed badly needed. It has been estimated, however, that on the assumption that an average family consists of four persons and that three acres are cultivated per family, 230,000 families, comprising about 37% of the Malaysian population,* are connected with padi cultivation. It is not at all certain, however, that the average area cultivated per family is as much as three acres. In many districts it is certainly less, though in a few it may be more. It is likely, therefore, that 230,000 families is below the actual figure.

Some idea of the overcrowding in certain districts may be gained from Figs. 1 and 2, which are plans of small areas selected at random from large scale maps. Fig. 1 shows an area of buffalo-ploughed land consisting of 12 lots comprising 33 acres, owned by 12 persons and cultivated by 15 padi planters with their families. Only four of the owners cultivate their own holdings, and the average area cultivated per family is 2.2 acres. Each of these padi planters could cultivate with his *present tools*, 8 to 10 acres, but not only is he cultivating only a quarter of this acreage

*Malayan census figures are of little help here as many padi planters may be rubber or coconut planters or fishermen as well.

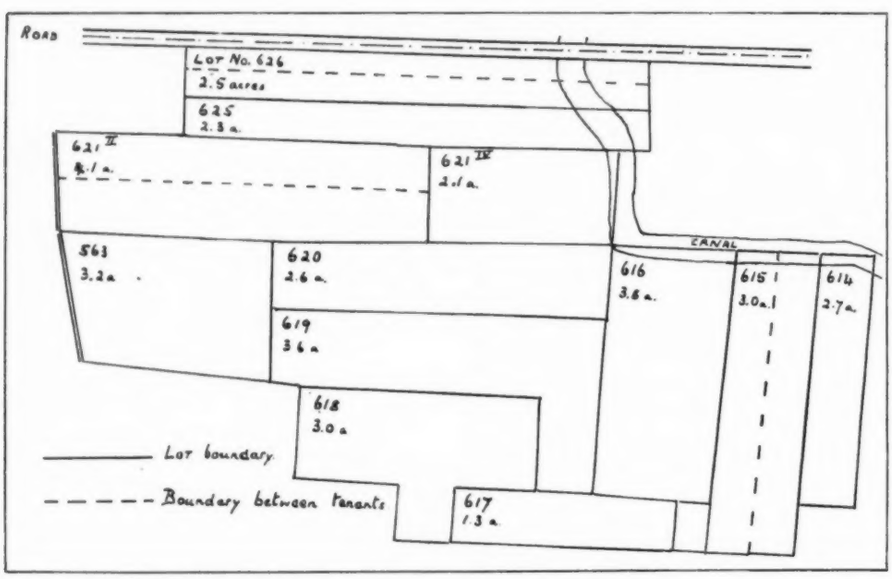


Fig. 1. Map of a group of buffalo-cultivated padi holdings showing the acreage of each and the subdivision between tenants

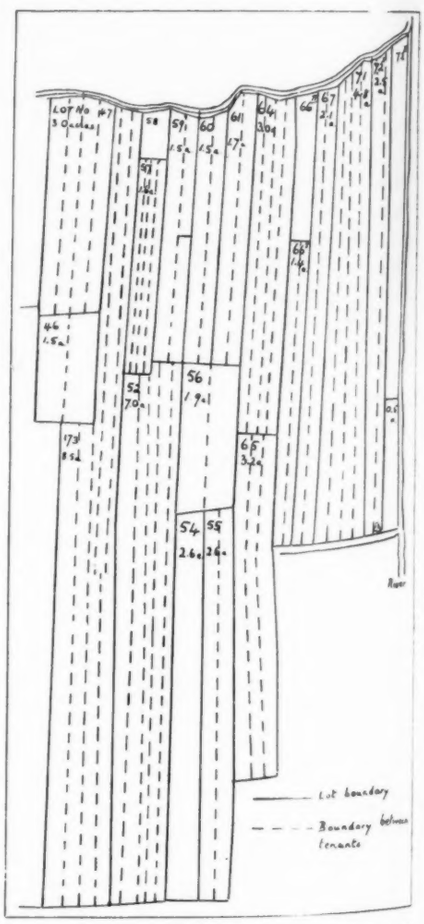


Fig. 2. Map of a group of 'tajak' cultivated padi holdings in a very overcrowded district; note the large number of subdivisions between tenants

Plate 1. The subdivision of padi holdings

Plate 2. Overcrowding in a Malay 'kampong'

but in eight cases out of the 15 he is paying one-third of his crop as rent to the landowner.

Fig. 2 is an extreme case, though the area was also selected at random within its district. It shows that 18 lots, already much too small, have been so subdivided among tenants that 52 padi planters are now cultivating 50 acres. Of these 52 planters only nine are land owners; the remaining 24 owners or part-owners do not cultivate the lots. A total of 77 persons with their families and dependents are in receipt of the produce of these 50 acres. The land is too deep to plough with buffaloes or cattle, and it is cultivated by hand with the large-bladed knife (the *tajak*). Nevertheless it could be worked by only eight to ten planters cultivating 5 or 6 acres each.

Plate 1 shows such an area of padi land in the off season. The bank running across the photograph from the left foreground is the transverse boundary of a number of long narrow lots running parallel to each other. The two boundary stones marked by sticks show the breadth of the first of these lots, while its longitudinal boundary on the far side is clearly indicated by the bank running from the second boundary stone to the boy standing on the extreme left. The longitudinal boundaries of the two lots behind are indicated by the padi planters standing on them. It will be noticed that the frontmost lot is so narrow that it has not been thought worth while to erect a bank on the nearside longitudinal boundary. All these lots are less than one acre in area.

Subdivision of the *kampong* lots is no less pronounced. As more and more families cultivate the same total area of padi land, more houses are put up in the *kampong* and less ground is available for growing fruit and vegetables. Plate 2 shows the resulting conditions. The three houses belong to three brothers, all now married and with families. Formerly only their father's house stood on this lot. Neighbours houses can also be seen in close proximity on the left.

Lack of credit facilities

Another unsatisfactory characteristic of existing padi areas is the lack of reasonable credit facilities. It is true that in may parts of Malaya the padi areas are constituted as Malay reserves in which land cannot be owned by people other than Malays or Malaysians. This serves to prevent the land itself from falling into the hands of the moneylenders. In other areas, on the other hand, the landowners have become heavily indebted to professional moneylenders or shopkeepers, in which event either the land itself falls into the hand of the moneylender, the original owner becoming a tenant, or, at best, the owner just keeps his head above water; in either event his ability to improve his holding is eliminated. In all areas producers are in the habit of taking loans, at high interest, on future crops and this has the effect of depriving them of a large proportion of their production. Attempts to alleviate this position by the encouragement of Co-Operative Credit Societies have been made but so far they have had but limited success. The number of Rural Credit and Seasonal Credit Society members dropped from 3,098 in 1928 to 2,017 in 1937; since the war the number has risen to 7,172, but this is still only 3% of the estimated total number of padi planting families. The working capital of these societies was less than £30,000 and constituted only 2½% of the working capital of all societies (95% of the total working capital was in Urban Societies and Labourers' Societies). No attempt has so far been made in Malaya to inject the Co-Operative Societies with funds derived from government sources or commercial banks.

To summarise, it may be said that in Malaya the existing padi areas could be cultivated with the type of equipment available to existing cultivators by a third to a sixth of the numbers actually engaged.* Secondly, there is a lack of sound credit facilities for improving padi and *kampong* holdings.

*At present there is what is hoped will prove to be a temporary situation in which many of the young men from the padi areas have joined the anti-bandit forces. It is noteworthy that padi production has not suffered from their absence.

The establishment of new areas

The establishment of new areas involves problems of land selection, administration, finance, land tenure and cultivation. The latter should be based on the results of previous research or, in its absence, on long-proved local experience. A further problem is presented by the arrival of mechanisation.

Land selection

A land classification survey as used in the United States and elsewhere, can be of enormous help in selecting new areas for agricultural development. At present likely looking areas are soil sampled and if they are found to be suitable in this respect, and provided an adequate water supply is available, they are ear-marked for development in padi cultivation and work is begun as funds become available. There is little doubt that a systematic land classification survey would bring to light many more areas than have yet been considered. Recently, when it appeared that the mechanisation of padi planting on peat and muck soils was going to prove very difficult and perhaps impossible, a search for further clay land was soon rewarded by the discovery of a number of possible areas.

Administration

In Malaya it is the practice to place new areas under the administrative supervision of the District Officer, who acts as chairman of a supervisory committee the membership of which includes government officials, local Malays and others. The local Drainage and Irrigation Engineer is in charge of irrigation and controls the construction and operation of the irrigation works. Planning of the progress of the scheme is done by the District Officer with the advice of his committee. The system is, in principle, a thoroughly sound one, for it assures that local schemes are controlled locally and not bureaucratically from some far-distant office. The committee which controlled such projects as the sizeable scheme at Sungei Manik in Perak, for example, have done excellent work. Nevertheless, such committees require a soundly conceived settlement and cultivation plan on which to work, as this ensures continuity particularly as District Officers tend to be transferred rather frequently. If such a general plan is lacking, wide and undesirable differences in the structure of settlement schemes may arise. For instance in the Sungei Manik scheme six acres of padi land were allotted to each family, but in a similar scheme at another point only three-acre lots were made available.

Moreover, in some areas local uninformed opinion may affect the programme to the detriment of the wider issues involved and lead to the creation of uneconomically sized holdings owing to local land hunger.

Thus it is of first importance that the settlement committees should work from the outset on plans which are agriculturally and economically sound. An Agricultural Department should possess the knowledge, based on research and experience, to enable reliable advice and guidance to be given on the type of scheme suited to particular areas, and this should be made fully available to the local committee.

Land tenure and cultivation

The system of land tenure in areas occupied by Malays is tantamount to outright ownership; with it is combined a traditional system of inheritance which leads to the subdivision of holdings between the sons and daughters of the owner. The result is that the holdings are generally fragmented until any further subdivision makes the plots too small to be economically worked. When this happens one of the sons or daughters usually sells off his or her share. The result is that holdings eventually become just large enough to give bare support to a family but not large enough to provide the family with sufficient work or a reasonable income, while increasing numbers of landless Malays accumulate on the holdings of their relatives and eke out a precarious existence by renting pieces of padi land where they can and by doing odd jobs.

If no new system is devised the same thing is bound to happen in new areas. All District Officers and Agricultural Officers are aware of this problem, but it is so hedged about with explosive possibilities that no one, one may suppose, has so far dared to attempt to improve the position and holdings continue to be alienated in the time-honoured fashion.

State ownership of land with the loaning of tenure holdings of economic size would have much to commend it though it would be initially unpopular. The advantages of government retaining the ownership of the land in peasant settlement schemes has been recognised in many places. It enables the tenant to be given reasonable security of tenure subject to satisfactory cultivation, and succession in the family can be retained without fragmentation. Padi lots could be ' tied ' to *kampong* lots and it should be made impossible for relatives to put up houses and to ' camp ' on *kampong* lots, thereby preventing their full agricultural use. State ownership has the further advantages that the introduction of mechanical cultivation would be less difficult, while tenancy agreements would ensure that the whole of the land is used.

If, however, a system of individual ownership must be adhered to, some method must be devised of overcoming the religious and customary rules which at present lead to subdivision and the subsequent impoverishment of the peasantry. Such a system, however, could not be imposed from above, it would have to be worked out by the Malay peasantry themselves with the help and guidance of the authorities after the peasantry have been brought to appreciate the dangers of the present position.

Finance and indebtedness

It is not possible to discuss this subject in any detail in the course of a short article. It must, however, be emphasised that unless suitable and adequate credit facilities are provided the evil influence of the professional moneylender and the credit-giving shopkeeper is certain to penetrate newly-opened paddy areas in a very short time. Elsewhere it has been shown that the development of co-operative credit can be greatly hastened by initial support from the government or commercial banks.

Other special measures which are desirable in the same connection are (1) the prevention of liens on future crops except to co-operative societies, (2) the control of land mortgages and (3) the discouragement of extravagant ceremonial expenditure. Measures of this type have been tried successfully in the Punjab, Indonesia and elsewhere, and experience gained there should be of much value in tackling the similar problem in Malaya.

Mechanisation

It may be anticipated that ultimately the results of the large-scale experiments on the mechanical cultivation of rice now in progress in Malaya will have a profound effect on new padi schemes. At present, however, the trials are by no means complete and it is only possible to speculate on what these effects will actually be.

The results of the trials to date may be summarised as follows. On peat, muck and deep organic soils (unploughable with buffaloes or cattle) successful mechanisation depends (1) on the improvement of drainage so that the land can be rapidly dried out, and (2) on the economics of the removal of submerged timbers. At present, all new areas with soils of this type are full of timbers which must be removed before the land is fit for mechanical cultivation.

On hard-bottomed clay land on the other hand (which can normally be ploughed

Mechanical cultivation of padi. Ploughing with a trailer plough before the onset of the rains

with buffaloes or cattle) there is little doubt that, as in British Guiana, full mechanisation will eventually become possible. Under these circumstances one may ask, what could be achieved and what population density would be justified?

In British Guiana it has been shown that one tractor working an eight-hour day can, in the course of three months, prepare 300 acres for planting, but the ideal conditions under which this can be achieved are rarely encountered. In Malaya something more might be expected of mechanisation than the mere substitution of the tractor for the buffalo. It has already been mentioned that off-season cropping is not only productive in itself but also improves the padi crop. If tractors are, however, to begin cultivation for the padi crop three or four months before sowing, then off-season cropping will not be possible. Mechanisation should, in my view, be used for obtaining more crops and better crops, and at least part of a mechanised area should be used every year for off-season crops. If this is done much more than one tractor per 300 acres will be required. In British Guiana 70 tractors have, in fact, been used on a 4,000 acre scheme. Though it is admittedly guesswork to try to estimate the number of tractors likely to be required in Malaya, it seems improbable that less than one tractor per 40 to 50 acres will be needed if full use is to be made of the tractors for cultivation. In these conditions it seems likely that the population required to assure the full and efficient use of the land might be reduced to about a sixth of that required under the existing methods of cultivation provided all operations were mechanised.

The question naturally follows, what would be the most effective way of organising such a population? Two alternative replies suggest themselves. In the first the whole area would be state owned and operated, a paid labour force being employed to carry out the work. In the second the land would be subdivided into holdings of, say, 40 to 50 acres each, which would be leased to peasants who would hire the machinery from a central pool. In both cases, however, and this is most important, the workers could and should have their own *kampong* holdings adjacent to the area on which they would have their house, grow fruit and vegetables and keep livestock in the traditional manner, although no doubt mechanical methods could render some assistance in the growing of vegetables. Under some such scheme the traditional structure of the existing Malay padi-plus-*kampong* system need not be shattered as a result of the impact of mechanisation, while considerable expansion would be possible both in production per acre and production per man.

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British Colonial Territories in 1950

The Central Office of Information publishes at fortnightly intervals, a review of Commonwealth affairs. The present publication* summarises much information previously published in Commonwealth Survey but with considerable additions. As a whole it provides a valuable summary of the main developments in the Colonial territories during 1950.

On the agricultural production side there is abundant evidence of progress. The reinstitution of the East African Production and Supply Council, which acts in an advisory capacity to the East Africa High Commission, as well as the development of the East African Agricultural and Forestry Research Organisation, is an important forward step. In Central Africa the schemes for development of the tung oil tree cultivation and extension of tobacco production represent major developments. In West Africa the Colonial Development Corporation's Niger Agricultural Project and the Damongo Project in the Gold Coast, the efforts to improve and extend the cotton industry and the oil palm industry in Nigeria are noteworthy advances. Notable also are developments in co-operation in the Far East, and despite the difficulties of the anti-bandit campaign the recovery of agriculture from the effects of the Japanese occupation is making excellent progress. Rubber production has been maintained at high levels while coconut, oil palm and pineapple industries are all well on the way to complete re-establishment. The important increase in Malaya's rice crop is another noteworthy occurrence.

In the Caribbean region an outstanding point is the further considerable expansion in sugar production, while the stability brought to the sugar industry as a result of the war and post-war selling arrangements is now assured for a further period by the recent sugar agreement. The expansion of rice production in British Guiana and Trinidad is also noteworthy, as is the expansion of citrus fruit production, notably in Jamaica. The steady expansion of agricultural research facilities at the Imperial College of Tropical Agriculture and elsewhere is also important.

In other Colonial spheres progress is recorded of the development of irrigation in Cyprus and the further increase in sugar production in Mauritius, which colony also benefits by the recent sugar agreement.

* Applications for copies, preferably written, may be made to the Central Office of Information, London.

Soil Conservation and Food Production

A. N. DUCKHAM

Formerly Agricultural Attache, British Embassy, Washington, D.C.

While there is general agreement as to the seriousness of the threat from soil erosion, there is some divergence of view, especially in the U.S.A., as to the degree of compulsion which should be exercised in applying conservation measures. We reproduce below an article by Mr. A. N. Duckham, discussing these points of view.

EVERYONE agrees that the loss of topsoil by water and wind erosion is a serious threat to the long-term economic welfare of many parts of the world. But the pros and cons of particular soil conservation techniques and programmes are sometimes somewhat obscured by pseudo-philosophical and even political considerations.

In the United States, however, there are two well-defined schools of thought. One school, which may be called the 'Moderate,' supports voluntary soil conservation, but dislikes any attempt to make soil erosion control compulsory or to require erosion control as a condition of governmental price and other subsidies to agriculture.

The other school (the 'Conservationist') stresses the view, which is relatively new in the United States, that men and natural resources are both national assets and must be conserved, *e.g.* by better social services and better soil conservation. The more far seeing of them seem to feel, in effect, that Americans can no longer expect to achieve production and wealth by metabolising goods and services which they did not produce, *e.g.* by using up indigenous soil fertility. Americans, they argue, must 'dress and keep the garden' if their children are to enjoy 'life, liberty and the pursuit of happiness.' Compulsory soil conservation may, such people feel, therefore be justified.

The second school of thought, which is closely identified with the United States Soil Conservation Service,* freely quotes the 'evidence of history.' It tends to argue that the Empires of Babylon, Athens and Rome melted, literally and metaphorically, into dust because they did not practise soil conservation. Apart from the fact that these Conservationists sometimes overlook an equally relevant historical fact, *i.e.* the gradual desiccation of the Middle East during some thousands of years B.C., they omit, the other side argues, to point out that these ancient empires had no modern science to offset soil erosion by higher crop yields from the use of fertilisers, improved varieties, pest control, etc.

Recently this debate has been enlivened by such books as William Vogt's 'The Road to Survival,' which points dramatically but not always convincingly to the rate at which world population is increasing on the one hand and the world's soil is being eroded away on the other.

In brief, the case against the Conservationists is that they preach soil conservation too much as a religion and not enough on its own merits as an economic proposition; and, that in some areas, especially in the south of the United States, their policy is technically unsound.

The Conservationist reply is that the United States Soil Conservation Service has made several million farmers conscious of soil erosion and persuaded hundreds of thousands of them to do something about it; that its technical propaganda was and is necessary to stir up farming opinion and create public interest in conserving national resources; that the technical validity of its policy is amply confirmed by the higher yields on farms which have adopted proper soil conservation measures.

This last claim is at least partially disputed by the Moderates and, as the tendency of some governments and individuals to regard the opinions of the Conservationists as fully authoritative and representative of United States opinion, hinges on the validity of its technical premises, they merit further investigation.

These technical premises were reviewed by Richard Bradfield, Head of the Agronomy Department, Cornell University, New York, who is well recognised as a fair-minded, well-travelled and able man. Speaking at a symposium on 'Food' to the Academy of Political Sciences, Columbia University, New York, he pointed out that the raw materials of soil (pulverised rock, air and water) are 'the must abundant and cheapest on the face of the earth,'* and are, ultimately, the source of the humus 'which coats the tiny grains into which the pulverised rock ultimately becomes weathered.'

A striking example of soil conservation in an arid region of Western U.S.A. Natural vegetation is allowed to grow during the first stages of reclamation in order to hold the soil and furnish shelter for pasture grasses

'Sense of Humus'

This humus is, in effect, the main bone of contention. Apart from its action as a sponge in equalising the supply of water and plant nutrients and in favouring microbiological action, a humus-rich soil is, of course, normally much more resistant to water or wind erosion than a soil containing little or no humus. Crops which are

*U.S. SOIL CONSERVATION SERVICE

The Soil Conservation Service (S.C.S.) maintains teams of soil-conservation experts who work throughout the entire country helping state extension (advisory) staff to organise soil-conservation practices.

The S.C.S. was formed in the mid-thirties when it had an annual expenditure of about $10,000,000. Today it costs about $40,000,000 per annum—a figure which is considerably less than its peak expenditures in the late thirties and early forties. In 1948, its operational costs were $38,000,000, whilst Government payments to farmers and others for soil, water and other conservation and land-improvement practices brought the total federal expenditure on conservation to some $400,000,000. In its earlier days it was and still is, to some extent, a method of subsidising agriculture. The S.C.S. has some 12,000 employees, of which 360 are primarily engaged in research.

*Proceedings, Academy of Political Sciences, January 1949, Vol. XXIV, 2, New York.

Desolation. Disappearance of top soil through overploughing, overgrazing, windstorms and drought rendered this Oklahoma farm useless for farming

Prosperity. Strip rotation of cotton and small grains followed by annual lespedeza, in South Carolina

grown in widely spaced rows (*e.g.* cotton, maize, soybeans, potatoes), not only leave more soil surface exposed to erosion but do not build up humus. Close-growing crops, like grass and legumes and to some extent wheat and oats and other small grains, not only reduce the exposed soil surface but help to build up humus. In the main agricultural areas of the United States (except the Great Plains) row crops are the major basis of farm income. They are generally more profitable than grass and clovers or small grains. There is thus a strong temptation to grow too many row crops, even when this results in severe erosion, because a sound rotation of wide and close-growing crops would tend, many farmers contend, to reduce their income.

The Conservationists deny this. They point out firstly that, in many cases, the adoption of sound humus-building crop rotations has doubled or trebled the yield of the major cash crop (*e.g.* cotton or potatoes), and that even if the humus-building crops, grasses and legumes yielded nothing, the extra yield on the cash crop would make soil conserving rotations profitable.

Secondly, the Conservationists argue that if soil conservation is not practised, the soil is washed away and lost as a national asset or blown away and literally 'gone with the wind.'

The Moderates and, more particularly the soil scientists, regard these claims as excessive.* On the first point they admit that humus-building increases yields. But they point out that in the southern United States and in hot climates generally, the high summer temperatures rapidly oxidise away the humus; that unless the soil is covered in winter by a close-growing crop, much of the available plant nutrients, particularly nitrogen are, in the southern United States, leached away by the heavy winter rains on the bare land; that it may be more profitable to rely on heavy dressing of artificial fertilisers to cash crops; and that it may be better to control erosion, if that is necessary, by purely physical means. A cropping policy of this type is in fact very largely followed by many farmers in the south (Louisiana, Alabama, Mississippi) whilst in large parts of Florida there is practically no humus in the soil, which is then treated by the farmer as though it were a sand culture.

As to the second point, the soil scientists state that soil which is washed or blown away is not necessarily lost and gone forever. Bradfield, for instance, disputes a statement by the Conservationists that the soil on over 1,000,000,000 acres in the United States has been essentially destroyed or is subject to 'destructively active' erosion. (This is two and a half times the total crop area of the United States but includes range land, forest and desert.) If erosion is as bad as these figures imply, why is it, Bradfield asks, that United States crop yields have in recent years been so outstandingly good?

The answer, which he does not supply, seems to be that the use of fertilisers, irrigation, the advent of hybrid corn (maize) and other gifts from the plant breeders, the greater use of agricultural chemicals to control insects, plant diseases and weeds, and the way in which mechanisation helps the farmer to beat the weather by doing the job quickly at the right time have, taken together, substantially more than offset any loss of crop yields attributable to the wastage of topsoil by erosion.

Is mild erosion beneficial?

Continuing, Bradfield shows that many of the best soils in the United States (*e.g.* the Mississippi Delta and those of the irrigated valleys in the Rocky Mountains) were formed and are still being formed by erosion of topsoil from land which is too rocky, too high or too dry to be cultivated. Even in less extreme cases, topsoil lost from an upland field or farm does not *all* get into the rivers—though the colour of many United States rivers is visible evidence that a great deal does—for some of it is deposited on lower fields or lower farms which are generally easier to work than upland farms.

*Bradfield points out that the most ardent soil conservationists are naturalists and ecologists and not soil scientists.

Further, even when the topsoil has been washed away, the underlying subsoil is, in the United States, usually as rich in all plant nutrients (except nitrogen and sometimes phosphorus) as the ' lost ' topsoil; indeed, Bradfield argues, ' there is some evidence that a moderate amount of erosion . . . is actually beneficial.' It is a way of rejuvenating the soil and of utilising the enormous reserves of plant nutrients in the subsoil.

Against this line, the Conservationists have claimed that it takes ' 300 to 1,000 years or more to bring back one inch of topsoil ' by regenerative processes. But Bradfield replies, ' experiments in which the entire topsoil has been removed by erosion ' have shown that provided enough subsoil remains, it can, by economically feasible systems of management, be made to produce yields well above the average for the country. For instance in Ohio in 1936, all the top soil (to plough depth) was removed from a block of land, the subsoil of which was then limed, fertilised, and put into humus-building rotations. Within four years the yields of maize on this land were (at 70 to 80 bushels p.a.) more than double the United States average. Similar examples could be quoted from other areas in the United States. These considerations lead Bradfield to the conclusions that the dangers of soil erosion, though great, should not be over-emphasised and that, if by the use of the better farming practices mentioned above, the yields of all United States farmers could be brought up to those of the best 10%, then the farm output of the United States would increase 50 to 75%.

This is probably true and is, paradoxically enough, probably the Conservationists' trump card. For, though it may be difficult to show that soil conservation *per se* is profitable to the individual, there is little doubt that soil conservation has catalysed better farming. American farmers co-operating in soil conservation districts benefit from detailed surveys and individual production programmes for their farms and from ' personalised ' technical advice which usually persuades them to use better adapted crop and grass varieties, correct fertiliser applications, etc.

Like propaganda for the use of phosphate in the T.V.A. region, of lime in Kentucky, of stubble-mulching in the Great Plains, the soil conservation programme provides a simple appeal upon which to hang a programme of ' better farming ' which has paid and is paying good dividends. Thus the indirect and incidental benefits of soil conservation have probably been as great to the individual as the direct benefits of soil erosion control. In other words, soil conservation may, in excess, be a bad master but, if used discreetly, it can be a good servant that makes a better master.

The ecological aspects (*i.e.* the use of humus-building rotations and of close-growing crops which reduce surface erosion, etc.) have been discussed above because it is round them that most technical controversy centres. The engineering aspect, on which there is a much wider area of agreement, is equally important. This is partly (a) because eroding soils have less ability to ' sponge ' up rainfall, which therefore runs off immediately and substantially contributes to silting up or scouring of rivers and to the flood disasters which frequently ' hit the headlines ' in the United States press, and (b) partly because both sides agree that terracing, grass runways for water, contour farming, strip farming, stubble-mulch farming and other mainly physical or engineering methods of keeping the soil in place are technically and economically sound.

Further, the engineering approach appeals more directly to the American mind, which is more machine conscious and less biologically inclined than the British. To many American farmers, soil (which he calls ' dirt ') is an inert commodity which you can shift around with a bulldozer; to most British farmers it is a living thing which needs the same care and attention as the crops it grows. The United States farmer is a good engineer; the British a good ecologist.

Conclusions

It is difficult, on such a highly technical and controversial subject, for the outsider to reach a fair conclusion. My personal conclusions, based primarily on my five years' experience in North America are, however, broadly as follows:

In North America, in spite of continued soil erosion, agricultural output in recent years has been increasing at about 3% per annum. This is a high figure which is, so far as I know, only equalled in the United Kingdom. But this fact and the evidence discussed above does seem to justify the conclusion that, provided physical means are taken to reduce excessive loss of soil, then the impact of modern science and industry on agriculture can continue to increase food production at a much greater rate than productivity is lost through soil erosion. In other words, advanced industrial countries or farming countries in a position, like New Zealand, to make use of modern scientific and industrial techniques need not fear starvation or even a reduced standard of living as a result of soil erosion provided that the soil is not wilfully wasted by profligate farming methods.

On the other hand, those countries where the population is growing rapidly, where every available acre has to be heavily cropped and which are unlikely for many years to come to be able to apply modern science and industry to agriculture, have a great deal to fear from soil erosion. High soil temperatures, the difficulty of sparing acreage for humus-building non-food crops, the need to use crop wastes (*e.g.* straw) for fuel, housing, etc., may combine to make it almost impossible to adopt ecological soil conservation techniques. Inertia, ignorance and archaic land tenure systems (and possibly lack of heavy soil moving equipment) may make it difficult to apply engineering methods to keep the soil where it belongs, *viz.* on the farms.

Under these conditions, soil conservation practices on the American model may be impossible of attainment. Whilst, therefore, it is not suggested that soil erosion control should be neglected, it should never be regarded as an end in itself. It would seem better to concentrate at least as much attention on raising yields and output. This would be done, of course, by using more fertilisers, agricultural chemicals, improved husbandry techniques and improved plant varieties and, when possible, by bringing more land into cultivation by irrigation, bush clearing and similar reclamation schemes.

American estimates (most of which are admittedly very rough) imply that, if this was done everywhere, world average crop yields could be increased by 20 to 50% and total world food output by 50 to 70%. Experience shows, however, that in less developed countries (whatever their potential natural resources) it is difficult to increase output at a greater rate than 1½ to 2% per annum, *i.e.* approximately the rate at which the expanding population of these overcrowded countries is growing.

Thus if this analysis is correct the main threat to these countries is perhaps not so much soil erosion as the Conservationist school suggests, but their difficulty (which may be variously due to poverty, ignorance, apathy, ill-health or the lack of capital or of export crops with which to buy fertilisers, etc.) in applying modern scientific and industrial techniques to food production.

The moral (at least to me) is obvious. As soil conservation and food production cannot be divorced, they might as well work as partners. Otherwise their marriage will not only be unhappy but sterile in terms of human progress.

From the East African Agriculture Journal, October 1950, xvi, 2.

Photos, U.S.I.S.

The new £2,000,000 sugar estate and factory at Monymusk, Jamaica

Industrial Uses for Sugar Cane By-Products

A Caribbean Commission Report

A RECENT report* by a British expert, Mr. Walter Scott, indicates how the international pooling of achievements in sugar technology can help to solve some of the economic problems of the Caribbean area. A fundamental problem has been the undue dependence on the production of a limited number of raw materials, such as sugar, which are subject to periodic booms and slumps in the world market. The industrial development of sugar by-products would increase the range of exports from the area.

Today the major products of the Caribbean sugar industry are raw (and small quantities of refined) sugar, molasses, rum and alcohol, and fuel in the form of bagasse.

Utilisation of bagasse

The report suggests that bagasse, the fibrous residue left after the juice has been extracted from sugar cane, which at present constitutes a serious disposal problem at the larger sugar factories, could be put to a number of useful applications.

Chemically, bagasse consists largely of cellulose and pentosans, both of which are elaborate compounds of sugars, and it is related to cereal straws, maize stalks and other agricultural residues industrially exploited in many countries. Bagasse itself is made into insulating material and hardboards for building in the United Kingdom, Australia, the United States and Hawaii. In Barbados, bagasse mixed with lime is moulded into prefabricated 'megacrete' units, from which in 1949 several three- and four-roomed experimental houses were built.

Bagasse can also be manufactured into cardboard, either smooth or corrugated, and into the lining material used on one or both sides of the latter. These products make excellent packing containers, and are in commercial production in the United States. Paper of various types can also be made from bagasse, either alone or mixed with other pulps. Some promising small-scale results in this field were obtained in Formosa during World War II, and, in 1950, newsprint made entirely from bagasse was produced in the United States.

Bagasse can alternatively be treated to yield valuable chemical products. Its cellulose component can provide alpha cellulose, which is the basic raw material of rayon, nitro-cellulose and, if sufficiently pure, of the cellulose acetate plastics. Encouraging results to this end have been obtained in the United States, Hawaii, Puerto Rico and elsewhere, and equipment to manufacture alpha-cellulose from bagasse by a continuous process is now in production.

The carbohydrates of bagasse can be chemically broken down to produce two simple sugars, dextrose and xylose. Dextrose is easily fermentable to alcohol and xylose converted to furfural, which has extremely varied applications in industry. A pilot plant for this two-product process is at work in the United States.

Lastly, an interesting range of bagasse plastics is in established commercial production in the United States. An important outlet for them is the manufacture of laminates—special products made of various materials bonded together by synthetic resins.

Utilisation of molasses

Another important residue is molasses, the remnant of the sugar cane juice from which no further solid sugar can be economically obtained.

Molasses is exported to the United Kingdom, where during World War I an important industry was started to ferment molasses into acetone and butanol. Other fermentation processes yield such useful chemicals as citric, lactic and aconitic acids. The latter, a possible starting material for synthetic rubber and plastics manufacture, is present in sugar cane juice, and economic processes for its recovery from molasses have been developed in the United States.

Edible yeast can also be produced directly from molasses. Two plants for this purpose already exist in the Caribbean area—the full-scale Colonial Food Yeast installation in Jamaica and a pilot plant in Puerto Rico.

Finally, molasses as such have considerable nutritional value; they are rich in iron—richer indeed than raisins and baked beans—and also in calcium. They can easily be made into a wide range of very attractive human foods.

Utilisation of sugar cane wax

The wax present on sugar cane to the amount of a few pounds per ton was commercially extracted from the filter cake as long ago as 1916, in South Africa. At the present time the main producers are Australia and Cuba. The crude wax produced in Cuba is sent for refining to the United States. Research work indicates that many uses other than the present ones of shoe polish, liquid floor polish and carbon paper can be expected.

*'The Industrial Utilisation of Sugar Cane by-Products,' issued by the Caribbean Commission, Headquarters at Kent House, Port of Spain, Trinidad.

Utilisation of different wastes

Bagasse and molasses together can be transformed into charcoal briquettes by the use of methods developed in Java by Netherlands technicians.

The two same materials can be combined by various techniques used notably in Trinidad and Hawaii into various forms of cattle food. One method, using sugar processing machinery and only the pith of the bagasse, gives a superior product and leaves the fibrous part of the waste for other applications.

Bagasse and ' dunder ' (distillery waste) have been used for about a century in Jamaica to make fertilising compost. At the present time the material is undergoing large-scale controlled trials at one big estate there.

Economic benefit

The report gives detailed consideration throughout to the local and world economic factors likely to affect the success of any of the processes in the Caribbean area, and an appendix tabulates the actual or estimated surplus of the various by-products.

The industrial development of sugar by-products would assist the area in solving many problems. Thus the main nutritional needs, protein and minerals, could be met by processing molasses into human foodstuffs or into feed for livestock. Housing could be improved by the more extended use of the ' Megacrete ' technique and by production of bagasse insulating material and hardboard. Fuel supplies could be augmented by the use of bagasse-molasses briquettes for domestic purposes. Fertilisers would be obtainable from bagasse and distillery waste. Paper supplies could also be substantially increased—the newsprint consumption of the entire British Caribbean, estimated at some 6,000 tons a year, could be supplied from the bagasse surplus of one large Jamaican sugar factory alone.

The production of substances such as alpha-cellulose and furfural, and of substitutes for important waxes such as carnauba and licuri, would provide a sterling area source of these commodities in international trade; at present these substances are imported into the United Kingdom from hard currency areas. The production of aconitic acid, for which an increasing demand is expected in the well-industrialised countries, can be carried out more cheaply from molasses than by the present indirect method which entails the preparation of citric acid by fermentation and its subsequent conversion into aconitic acid.

Photos, Tate and Lyle Ltd.

Bagasse, normally used as a fuel, has a number of other uses which could well be exploited

Research Grants for American Agricultural Chemists

Grants ranging from $5,000 to $10,000 annually are being offered by the Herman Frasch Foundation to universities and other non-profit incorporated institutions in the U.S.A., to aid research in agricultural chemistry.

Designed to stimulate research which will be of practical benefit to the agricultural development of the United States, the grants are made every five years from a trust fund under the will of Elizabeth Blee Frasch in memory of her husband, Herman Frasch, the noted chemist, who invented the process of mining sulphur by steam.

The grants will be made for a one-year period commencing January 1, 1952, and will be renewable for four succeeding years, subject to annual review and approval of progress.

Recipients will be chosen by the United States Trust Co. of New York, as trustee, with the advice of the American Chemical Society. Interested institutions should submit applications for grants before July 1, 1951, to the Foundation, United States Trust Co. of New York, Trustee, 45 Wall Street, New York 5. Each application should contain the following information: (1) An outline of the research project, (2) the potential practical benefits of results, (3) the facilities available, (4) qualifications of available personnel, (5) anticipated time for completion, (6) an itemised estimate of annual expenditures for salaries, supplies, apparatus, and the like.

OFC Chairman Resigns

It has been announced by the Minister of Food, Mr. Webb, and by the Secretary of State for the Colonies, Mr. James Griffiths, that Sir Eric Coates has asked to be released from his appointment as Chairman of the Overseas Food Corporation so that he may be free to take up other employment. He will leave the Corporation in the early summer and will be succeeded by Mr. Stuart Gillett, at present Director of Agriculture in Kenya. Mr. Gillett joined the Corporation early in April as Chairman Designate and will be appointed Chairman from the date of Sir Eric Coates' departure.

Mr. Gillett, who was born in 1903, joined the Colonial Agriculture Service in Kenya in 1928 and became Director of Agriculture in 1948. He has wide experience of East African agricultural problems and, in particular, of large scale financial administration in organising the post-war scheme of the Kenya Government for the settlement of new European farming areas and the development of pilot schemes to determine the best pattern of African group farming involving capital investment and limited mechanisation.

As regards the members of the Board, as has already been announced, Sir Donald Perrott and Mr. McFadyen will be leaving shortly. Sir Charles Lockhart will continue as a part-time member. Sir Cyril Jones will continue as Finance Member until the end of the year when the position will be reviewed.

With the transfer of the Corporation to East Africa the London Office will be reduced from a staff of 115 to about a dozen.

NEW BOOKS

The Wealth of India

A Dictionary of Indian Raw Materials and Industrial Products. Vol. II. Pp. xx and 427. Illustrated. Council of Scientific and Industrial Research, New Delhi, 1950. 40s. or Rs.25.

This is the second volume of the monumental compilation which the Indian Council of Scientific and Industrial Research have undertaken, the first volume having been published in December 1948. Its aim is to provide an authoritative work of reference in encyclopaedia form concerning all types of raw materials produced in the Indian Commonwealth.

It is now approximately 60 years since Sir George Watt's 'Dictionary of the Economic Products of India' was first published. That great work was for many years the standard source of reference to Indian products. It was the pioneer effort of its kind and will always stand as a monument to its author's erudition and industry. The period which has elapsed since its publication has been one of rapid change in India. Much new knowledge has accumulated, while the demand for properly documented and critically appraised information has greatly quickened. Much of the information contained in Watt's original work has become out of date and on this account the Council undertook the present compilation which is designed to replace and bring up to date the earlier work.

The work has been entrusted to Sri B. N. Sastri as Editor in Chief with a staff of some 20 assistants, while a number of the longer articles have been written by external contributors, each of whom is an accepted authority in his own field. The result to date is the production of two volumes which must surely be unique in regard to the wealth of information they contain, while the manner in which it is presented reflects great credit on all concerned. It is presumably to be anticipated that a number of years must elapse before the work has been completed, but when this occurs, and provided the present standard is maintained, it will constitute a memorable achievement, especially as, although the book refers primarily to India, that country has no monopoly of most of the products dealt with.

The present volume covers materials beginning with the letter C, and it is nearly twice the length of its predecessor which treated those having the initials A and B; incidentally, it is remarkable what a large number of products have that initial.

It may, perhaps, be invidious to pick out individual items for special praise, but the long articles on cocos (coconuts) by Dr. R. Child, on camelia (tea) by Dr. P. H. Carpenter, on corchorus (jute) by the Indian Central Jute Committee, on coffea (coffee) by the Department of Agriculture, Mysore, and on citrus by Shri K. C. Naik are particularly noteworthy.

The work is admirably printed on high quality paper and profusely illustrated by figures in the text and 17 plates, a number of which are beautifully coloured; it is well documented with references to original papers.

The succeeding volumes will be awaited with considerable interest.

Farm Mechanisation

By Claude Culpin. Pp. ix and 147. Illustrated. Crosby Lockwood, 1951, 10s. 6d.

Farm Mechanisation, as opposed to the now standard work, *Farm Machinery*, is a book which deals purely with the economic aspects of power application. Here, Mr. Culpin, having described the construction and maintenance of farm implements and machinery in his earlier volume, goes a step further and discusses their practical application in Britain. His object, as he states, has been to bring out those points which are of importance in assessing the economics of buying and operating the various types of machines.

Amongst not a few farmers there is the misconception that the addition of, say, an extra tractor or a combine harvester to the farm will automatically bring in its train greater efficiency and profit. This is not by any means true. Purchase of the machine is only the beginning and it must be decided before buying exactly what saving in labour is likely to result (labour costs being the greatest item of expenditure on the great majority of farms); this figure must be set against the estimated depreciation and running costs of the new machine. And there are other non-financial aspects to be taken into account as well, such as acceleration of certain farm operations, elimination of back-breaking work for the farmer and his employees, increasing the amount of leisure for the family farm and so on. These last cannot be translated into terms of money; nevertheless, they cannot be discounted when mechanisation changes are being made.

That, very roughly, is the theme of this book. Again and again the author stresses the point that, when citing a specific example of mechanisation, he cannot generalise on the result, since every farm is an individual organisation, different from any other, and the book only brings out points with which some farmers have been confronted when mechanising. There are many examples throughout, taken mainly from statistical information which has been published during the last ten years, mostly by the provincial advisory economists and a great deal of it not seen by many farmers. Much of the book constitutes a review of this interesting information, which will no doubt please those who have put so much work into these statistical surveys and not always had the gratification of knowing that they were being widely read.

After a chapter on general considerations the book is divided into longish chapters on farm power, crop production machinery, fodder conservation machinery, corn and root harvesting machinery and stationary machinery and transport. In each chapter the various machines, their labour requirements and methods of working are described and the pros and cons of various ways of doing the job on different farm types discussed.

After reading this book many farmers will ask themselves whether their machinery management is as perfect as they thought, because *Farm Mechanisation* does stimulate the imagination and makes one realise that efficient management is complementary to efficient mechanisation and is by no means easy to achieve. Provided the importance of statistics is not over-emphasised in the reader's mind and he thinks along the lines of practical possibilities (as opposed to impractical ones), Mr. Culpin's book will be of real help and interest to farmers and, in fact, all students of farm mechanisation.

R.G.P.

Chemical Control of Insects

By T. F. West, J. E. Hardy and J. H. Ford. Pp. xi and 211. Illustrated. Chapman & Hall, London, 1951. 15s.

The Frontiers of Science series published by Messrs. Chapman and Hall is designed to provide information on recent scientific advances which is capable of ready comprehension by those with an elementary knowledge of scientific principles; as such it fills a decided gap. Previous volumes have dealt with such subjects as atomic energy, proteins, cosmic rays and animal nutrition.

The present volume is the sixth to be published. Its authors are known authorities on the subject and have given a lucid and interesting account of many aspects of this important subject which is having an ever-increasing influence on human affairs.

The first four chapters deal with general considerations and include a very con-

densed account of the salient points of insect behaviour which are essential to the understanding of what follows. Subsequently, the general principles involved in their control are discussed with a special chapter on the use of fumigants. The remainder of the book is devoted to a description of the various insecticides in use and a discussion of the action and application, with a short concluding chapter on weed control. Naturally the greatest amount of space is given to the chlorinated persistent insecticides of which DDT is the best known example. The discussion under each head is well documented, while it is at the same time clearly and attractively written.

In a subject which is changing and advancing with kaleidoscopic rapidity it is almost impossible to present a completely up-to-date account in a book. In this case the latest references quoted date back to 1947 and since then there have been some important advances which are not mentioned. Thus, for example, although Parathion is discussed there is no mention of the development of the systemic insecticides of which Schradan is the best known so far. Moreover, there have recently been one or two notable additions to the chlorinated insecticides and these also find no place. It is inevitable, however, that this should be the case.

Apart from this the book can be cordially commended to the audience to which it is primarily addressed, while it should also be invaluable to students, agricultural officers, farmers and planters who wish to possess a reliable and well-written account of the scientific basis of a subject which is of great and increasing importance in their own non-specialist fields.

Cereal Varieties in Great Britain

By R. A. Peachey. Pp. 202. Illustrated. Crosby Lockwood, 1951, 21s.

Here, for the first time, as far as we know, all the known varieties of wheat, oats and barley grown in Great Britain are fully described and illustrated. Altogether 67 varieties of wheat, 61 varieties of oats and 18 varieties of barley are described. Naturally some of these are little known except in localised areas of the country, but every variety mentioned is known to be grown commercially in Britain today.

Mr. Peachey, himself a trained plant breeder, carried out trials on the majority of branches mentioned and the information given is based largely on five years' observations and trials carried out on light land in the centre of England; this point is stressed in the Foreword for the benefit of observers under other conditions.

Each of the three sections is prefaced with a general discourse on the cereal, its origin, general description, climatic requirements, etc. Then, a page is devoted to each variety, giving its origin, principal characters and general information in some detail. A life-size (oats one-third life size) photograph is given of each variety.

As a work of reference this book should prove invaluable to plant breeders, seedsmen, students and all farmers who appreciate the importance of suited varieties for their land. In this latter connection Mr. Peachey says, 'Only by trials and more trials can the many types (of cereals) be sorted out and the best brought to the farmer's notice.' His book should do much to stimulate interest amongst farmers and encourage them to carry out trials themselves.

Fruit

Compiled in the Intelligence Branch of the Commonwealth Economic Committee. Pp. xv and 116. H.M.S.O., 1950, 5s.

This is another of the Commodity Series giving in summary form for the war and post-war years the chief statistical data of world production and trade for the commodities concerned. We have in these pages reviewed 'Grain Crops,' 'Plantation Crops' and 'Industrial Fibres,' and this month we mention 'Fruit' and 'Vegetable Oils and Oilseeds,' thus completing the five crop groups, the figures for which are revised annually in these reports (two others in the Commodity Series are 'Meat' and 'Dairy Produce').

'Fruit' is a summary of figures for production and trade relating to fresh, canned and dried fruit and wine up to 1949. The output of most fruits, except for wine grapes, is now greater than ever before, and canned fruit production is also increasing both in the United States and Commonwealth countries. The United States is now the main producer of apples, pears, plums, cherries, apricots and peaches, and also citrus fruits (oranges, grapefruit and lemons).

International trade in fresh fruit has shown a marked recovery since the war and exports in 1949 were only about 15% less than in the pre-war quinquennium. Wine production is gradually recovering in Mediterranean countries and in 1949 it exceeded 3,500 mill. gal. compared with 4,200 mill. gal. pre-war. The wine industry in South Africa and Australia is still relatively small, amounting in 1949 to 93 mill. gal.

The above are a few items from this book which covers the production and trade of 14 fruits, canned fruits and wine in a thorough and reliable fashion.

Vegetable Oils and Oilseeds

Compiled in the Intelligence Branch of the Commonwealth Economic Committee. Pp. xiv and 118. H.M.S.O., 1950, 5s.

This is a summary of figures of production, trade and consumption relating to groundnuts, cottonseed, linseed, rapeseed, soya beans, sunflower seed, sesame seed, castor seed, coconut and oil palm products, olive oil, tung oil and miscellaneous vegetable oils. Figures cover the years up to 1949, making this second post-war edition more up to date than the 1948 edition, in which fuller details for the war years were published.

In the general review given at the beginning of this publication it is stated that the steady improvement of the world oils and fats situation resulted in a greater world output in 1949 than pre-war. But, owing to the rise in world population the supplies per head are still well below those of pre-war.

The British Commonwealth accounts for over one-fifth of world production and for one-third of world exports of vegetable oils. India remains the leading producer, but British West Africa is now by far the largest exporter. Oil shipments from West Africa in 1949 were 20% above the pre-war level.

Over a hundred tables help to give a comprehensive picture of the post-war vegetable oil situation and the publication may be recommended to all those who have interest in these important staples.

New Publications

The following books, published during February and March of the current year, are available from the Book Department, WORLD CROPS, Leonard Hill Ltd., 17 Stratford Place, London, W.1:

Crops' Varieties, by H. Hunter. Illustrated. Pp. 244. Spon, London, 21s.

Forage and Pasture Crops, by W. A. Wheeler. Pp. 752. Macmillan, 60s.

Maize in the Great Herbals, by J. J. Finan. Illustrated. Pp. 43. Chronica Botanica, 24s.

Mechanical Agriculture, by Cornelius Davies. Illustrated. Pp. 122. Temple Press, 8s. 6d.

Organophosphorous Compounds, by G. M. Kosopaloff. Pp. 376. Wiley, 60s.

Plant Pathology, by John Charles. Illustrated. Pp. 699. McGraw Hill, 64s.

Potter's Cyclopaedia of Botanical Drugs and Preparations, by R. C. Wren. Illustrated. Pp. 415. Potter and Clarke, 10s. 6d.

Recent Advances in the Study of Plant Viruses, by K. M. Smith. Illustrated. Pp. 300. Churchill, 22s. 6d.

Wheat Production in Tanganyika

N. R. FUGGLES-COUCHMAN

Overseas Food Corporation

It is now accepted that an integral part of agricultural policy should be the encouragement of production locally of as large a part of a country's food requirements as is economically practicable. The following account exemplifies the difficulties that have been overcome and the extent to which local circumstances have had to be taken into account in order to develop the cultivation of wheat in Tanganyika.

ALTHOUGH wheat cultivation was introduced by missionaries in the southern areas of Tanganyika Territory as early as 1898, and Boer farmers were growing wheat in the Northern Province early in this century, it was not until 1935 that wheat cultivation really began to show expansion. Production of any importance is still confined to two main areas, the Northern Province and the Southern Highlands Province (with Songea district) in latitude 3° to 4° S. and latitude 8° to 10° 30′ S. There is a very small African production in the highland blocks of the Eastern and Tanga Provinces, largely retained for local use. Recently, with the opening up of the Mpanda mine, native production has developed in the Ufipa Highlands of the Western Province.

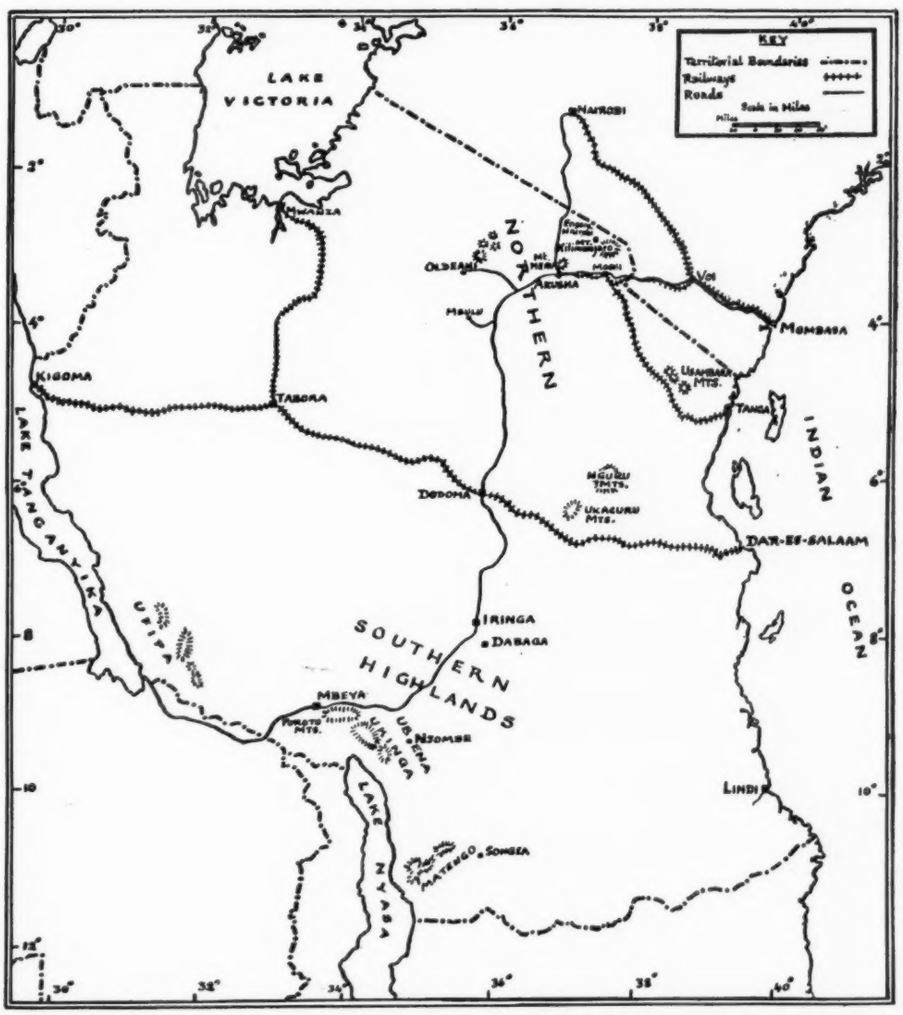
Growth of the industry

Between 1925 and 1929 the Department of Agriculture introduced small quantities of seed wheat to several of the highland areas, for trial in native cultivation both for food and as a cash crop. Wheat quickly found favour with the natives in the Matengo hills of Songea and in Njombe district, where it has become an important feature of native agriculture, particularly as a food crop. Extension of the crop by European farmers was encouraged by the opening of small flour mills at Dabaga in 1932 and at Iringa just prior to the war, largely as a result of the development of the Lupa goldfields. Up to 1937 the Southern Highlands were the only important producing area.

Although a small mill was in operation in Arusha in 1932 the farmers' acreage remained small. The real expansion of production in the Northern Province dates from the free distribution of seed by the Department of Agriculture to farmers in 1934, following two years of severe drought and crop failure. From 1937 to 1939 there was a rapid extension of wheat growing by European farmers around Arusha, encouraged by a protective tariff on imported wheat flour, and some extension by Africans.

By 1939 the farmers of the Northern Province had formed a Wheat Growers' Association. Thus, by the outbreak of the war the wheat crop was well established, considerable experience in its husbandry had been obtained and it was possible quickly to increase acreages further. Guaranteed prices, well above pre-war level, made wheat profitable at greater distances from railheads, which brought into cultivation land of high fertility, at Oldeani for instance. The growth in the territory's wheat acreage is shown in Table 1.

The Northern Province is now by far the most important area of production.



Tanganyika Territory, showing wheat growing areas in the Northern and Southern Highlands

Wheat is grown on a more or less fully mechanised scale on the western slopes of Kilimanjaro, to the north-east, west and south-west of Mt. Meru, and on the southern slopes of the Oldeani mountain block in Mbulu district. There is a considerable African production on the southern slopes of Mt. Meru and scattered through Mbulu district.

During the war, and purely as a war measure, 22,000 acres of new land were brought into production by a Government-sponsored wheat production scheme. Part was adjacent to proved wheat areas; the remainder in a great area of open grassland in Masailand, to the west of Arusha, with a marginal rainfall. The scheme came in for considerable criticism; nevertheless, over 200,000 bags of wheat were produced in five years when East Africa was desperately short of food, thereby saving valuable shipping.

Whereas the Northern Province is connected by rail to the ports of Mombasa and Tanga, and no wheat-producing area is more than 100 miles from a railhead, the southern wheat areas are between 190 and 350 miles from the railway. While the production from the Northern Province can be distributed as flour to a great part of the Territory, export from the south is at present uneconomical; the aim of production there has been to render the area as nearly self-supporting as possible.

Production

Prior to the building of a large modern mill at Arusha in 1945, the greater part of the wheat produced in the northern area was railed to Kenya for milling. Exports rose from 200 tons in 1937 to 1,430 tons in 1939, reaching the record figure of 4,511 tons in 1945. Since then, the crop has been milled at Arusha and exports have fallen to nil. Production from 1934 is shown in Table 2.

Production conditions

Wheat is not generally grown below an altitude of 4,300 ft., nor in the Northern Province above about 6,300 ft., although much African-grown wheat in the Southern Highlands is found between 6,000 and 8,000 ft. At higher altitudes yellow rust prevents the cultivation of some varieties, while below 4,300 ft. leaf and stem rusts become serious limiting factors for rain-grown wheat. With irrigation, wheat can be grown at lower altitudes in the dry season, as at Rujewa in Njombe district, and in the Northern Province, on a small scale, at 2,300 ft.

Generally speaking, the economic production of wheat becomes most uncertain where the annual rainfall is below 25 in., of which three-fifths should fall in the growing season. In the north, rainfall governs the areas in which wheat can be grown successfully, whereas in the Southern Highlands it is the low fertility of much of the land which restricts production, despite a suitable climate.

The Northern Province is in the belt of monsoon or two-season rainfall, with 'short' rains in November or December, which are unreliable. The 'long' rains, on which the crop is produced, fall in the period March to June, and vary from 9 to 29 in. in the main wheat areas. Kilimanjaro and Mt. Meru cause considerable rain shadows over surrounding areas of otherwise good wheat land, the cultivated area being the lower fringes of two islands of cultivation lying in the midst of a large dry zone; their use is only made possible by the comparatively restricted precipitation caused by the two great mountains.

The Southern Highlands are in the region of one-season rainfall, from November to April or May. The annual rainfall ranges from 30 in. at Iringa to over 60 in. in the Ukinga Highlands and parts of the Poroto Mountains. The heavy annual rainfall and high altitude make the choice of varieties and planting dates difficult, if losses due to rust are to be reduced to a minimum. In fact, high rainfall is a disadvantage in wheat production, and some of the best crops ever produced in Tanganyika were grown in the Northern Province in the dry year of 1946, on 15 in. of rain. Mists and dew often delay harvesting operations and encourage the development and spread of rust.

The most productive wheat soils in the Territory are the red volcanic loams on the south and south-eastern flanks of the Oldeani block, and on the higher parts of the western slopes of Kilimanjaro. Some of the volcanic soils in the Poroto Mountains of the Southern Province, farmed entirely by Africans, are probably of equal fertility. The volcanic ash soils of the Arusha area are also of high fertility and productive capacity, but continuous cropping with wheat has resulted in dirty fields and yields below optimum. While not now being used to any considerable extent, the fertile calcareous black clays of the Masai steppe have produced some good crops of wheat. They are, however, extremely difficult to manage in the planting season. Their productiveness depends almost en-

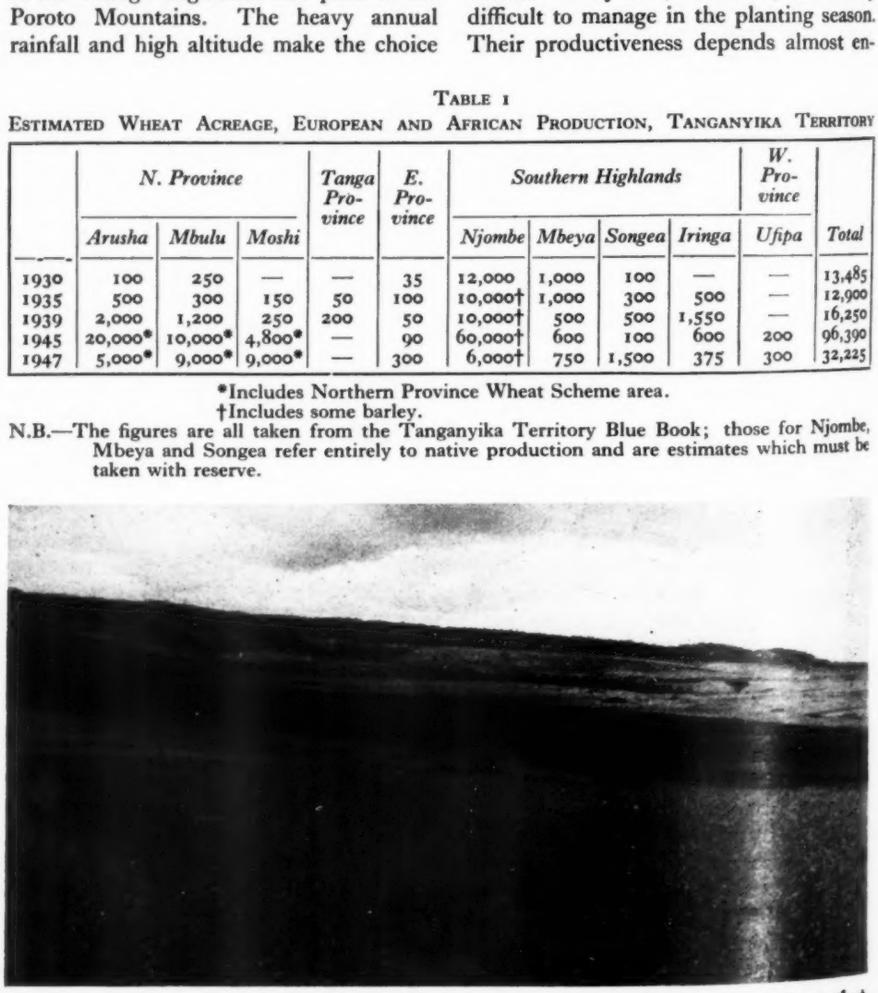
TABLE 1

ESTIMATED WHEAT ACREAGE, EUROPEAN AND AFRICAN PRODUCTION, TANGANYIKA TERRITORY

	N. Province			*Tanga Province*	*E. Province*	*Southern Highlands*				*W. Province*	*Total*
	Arusha	*Mbulu*	*Moshi*			*Njombe*	*Mbeya*	*Songea*	*Iringa*	*Ufipa*	
1930	100	250	—	—	35	12,000	1,000	100	—	—	13,485
1935	500	300	150	50	100	10,000†	1,000	300	500	—	12,900
1939	2,000	1,200	250	200	50	10,000†	500	500	1,550	—	16,250
1945	20,000*	10,000*	4,800*	—	90	60,000†	600	100	600	200	96,390
1947	5,000*	9,000*	9,000*	—	300	6,000†	750	1,500	375	300	32,225

*Includes Northern Province Wheat Scheme area.
†Includes some barley.

N.B.—The figures are all taken from the Tanganyika Territory Blue Book; those for Njombe, Mbeya and Songea refer entirely to native production and are estimates which must be taken with reserve.



Rolling wheat land on rich volcanic loams, Northern Province. It was here that 3,600 acres averaged 32 bushels/acre in 1946

Large-scale mechanised wheat production in the Northern Province. Drilling newly broken land

tirely on the distribution of the annual rainfall of not more than 20 in. With ideal distribution, these soils have produced above-average crops over large areas. They are very moisture retentive and might be kept in production by dry farming methods. An average crop has been produced in a drought year where the soil was clean fallowed in the previous season.

Although there are very considerable areas of soils in the Southern Highlands Province lying at the right altitude for wheat, and with sufficient rainfall, large areas of soil in Iringa district are extremely deficient in phosphate, and compact on drying out. There are, however, pockets of good soils lying on the lower slopes and in the bottoms of valleys which have produced average crops for the Territory.

In the Njombe district, at lower altitudes, the soils are compacting, light-red sandy loams. The best stands of wheat are usually on fields which have been drawn up into wide ridges. In the Ukinga Highlands, where the greater part of African production is centred, the soils are loose, puffy, grey-brown clay loams. The wheat is mainly grown on steep slopes without ridging, many of the steeper fields being terraced with wide, sloping bench terraces.

Cultivation

With the exception of a little ox-work on the smaller farms, production of wheat in the Northern Province is now fully mechanised. The impetus to production brought about during the war, with as much as 1,000 acres on a single farm, made the general introduction of the combine-harvester essential. Production in the south is not as fully mechanised as in the north. Some fields were sown broadcast and hand-reaped as recently as 1946. Individual areas are smaller and scattered making the introduction of combines, even on a co-operative basis, less attractive.

In the Northern Province the stubbles are ploughed before the short rains. Much of this work can be done cheaply by harrow-plough. The short rains are a most important factor in lightening the work in the planting season as, provided they are good, weeds come away and the land can be cleaned. When they fail, weeds often gain the upper hand in the heavier soils during the planting season, delaying sowing and thus reducing yields.

In the single rainfall season of the south, where wheat sowing does not take place until the latter half of the rains, ploughing is left until after their onset. Weed control at the height of the rains may, however, be difficult.

Wheat production by Africans is almost entirely by hand. Around Arusha the land is shallowly ploughed by ox-drawn single-furrow ploughs. During the war, production was assisted mechanically by a peripatetic threshing outfit, to which the Africans brought in their sheaves by hired lorry or on the backs of their donkeys. Where ploughing is not possible, the land is lightly dug by hoe. In Ubena and Ukinga, broad ridges are often drawn up, on which the wheat is broadcast. These broad ridges, purposely set on the contour, are of considerable value in soil conservation.

Sowing

The time of sowing is a particularly important factor in successful production of wheat in Tanganyika. It is related to the expected onset and duration of the rains and the danger of rust damage. It has been shown in dry areas of the Northern Province that early sowing after the long rains start gives optimum crops. In heavier rainfall areas planting is generally delayed until mid-April, except where it is necessary to grow longer-term wheats with yellow rust resistance. Delayed planting in the low-altitude, but good-rainfall, area near Arusha has been a common practice in an endeavour to escape the worst effects of stem rust. In the Southern Highlands, with heavy rain in January, February and March, the planting season varies between early February and mid-April, being generally later in the higher wetter areas where the incidence of stem and yellow rusts complicates the issue.

Wheat is generally drilled at 50 lb. per area and trials in drier areas have shown no yield increase from heavier seeding. In wetter areas a higher seed rate may be desirable, and there is scope for investigation on this subject. Africans generally broadcast at a rate of 60 to 70 lb. per acre.

Erosion control

While wheat, once established, is a good soil-conservation crop, there is consider-

TABLE 2. WHEAT MARKETED IN TANGANYIKA TERRITORY, 1934-48 (TONS)

		1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948
Southern Highlands	European	120	300	N.A.	455	261	46	N.A.	N.A.	N.A.	N.A.	N.A.	110	100	50	98
	African	Nil	70	Nil	N.A.	N.A.	100	249	232	332	410	234	577	425	620	420
Northern Province	European	Nil	Nil	N.A.	N.A.	256	1,293	1,566	1,699	2,220	2,331	3,874	2,549	2,754	1,985	3,326
	African	40	21	N.A.	N.A.	N.A.	257	1,566	383	780	891	827	739	132	274	336
	N.P.W.S.*	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	4,000	6,837	5,350	2,267	Nil
W. Province		Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	31	222
TOTAL		160	391	N.A.	N.A.	N.A.	1,696	3,381†	2,314†	3,332†	3,632†	8,935†	10,812	8,761	5,227	4,402

*Northern Province Wheat Scheme. N.A. Not available. †Excluding Southern Highlands European production.

able danger of erosion during the early part of the rains, especially as so much of the wheat area lies on sloping land. Adequate measures are required to reduce this danger, including physical conservation works, the conservation of crop residues, rotational cropping, and contour cultivation and drilling. The most satisfactory physical works have proved to be the broad-base drainage terrace, on which wheat may be grown mechanically and no land is left to grow weeds.

Unfortunately there has been a tendency to burn off combined stubble, but experiments have demonstrated that ploughing in the stubble can give a 25% increase in crop. For various reasons rotational cropping has not been widely practised. Rotations that have been used include maize and beans, following several years of wheat. In African areas the wheat often follows peas or beans, but finger millet and maize are other important crops in the rotation. The introduction of resting periods under grass in wheat land in alienated areas requires investigation.

Weeds

Weeds soon become a serious problem, especially where three or more wheat crops are taken in succession. Even in new land, weeds have been known to give considerable trouble on black clay soils. Three of the most persistent weeds are a species of *Amaranthus*, *Chenopodium album*, and the blue-flowered *Commelina benghalensis* on the heavy clay soils. Thorn Apple (*Datura stramonium*), particularly frequent in the volcanic ash soils near Arusha, has to be rogued by hand, as the seed is highly toxic. Control of weeds is considerably assisted in the double rainfall area if there are good short rains. Some can be reasonably adequately controlled while still in the seedling stage by the cleaning action of the disc coulters on the seed drills, but those of very quick growth can seriously affect yields in the drier areas.

Manuring

With the exception of the use of kraal manure on some low-fertility soils in the Southern Highlands, with disappointing results, fertilisers have not been used commercially on wheat in Tanganyika. It is doubtful whether the phosphate-rich soils of the north would show any useful response to phosphatic fertilisers; in areas where they might be useful their cost has been prohibitive. Under dry conditions no responses have been obtained from dressings of sulphate of ammonia, and the value of nitrogen in wetter areas remains to be shown.

Threshing native grown wheat near Arusha. The thresher is set up at several centres, to which the Africans bring their sheaves by donkey or lorry

Yields

A yield of 17 bushels per acre is a fair average crop, but fertile soils in a favourable year produce considerably more. In 1946, 3,600 acres of wheat under one management averaged 32 bushels per acre, while in 1943 and 1944, 2,500 acres in similar country averaged 23 bushels per acre. Individual crops of up to 43 bushels have been obtained from much smaller acreages. African yields average about 10 bushels.

Varieties

The development of suitable varieties of wheat for East African conditions has been closely related to questions of rust resistance. Strains bred and selected for Kenya conditions have been generally suitable to Tanganyikan conditions, provided due care has been taken in regard to altitude, as varieties in Tanganyika tend to become susceptible to yellow rust at somewhat lower altitudes than in Kenya.

The plant breeder has been faced with a complex problem. He has had to find strains with resistance to both stem and yellow rust, combined with agronomic characters suitable to the wide range of altitude, soils and climate of the wheat areas. In addition, the miller's requirements had to be met as far as possible. One of the greatest difficulties has lain in finding stem-rust-resistant wheats of good quality. Moreover, resistance to stem rust would appear good at first, only to ' break down ' after a period, especially as new biological forms of stem rust developed year by year. In 1931 four forms were known; nine forms have now been identified.

The first plant breeder in Kenya was appointed in 1912 and, before the first world war interrupted work, had produced the high-altitude variety Equator, which is still grown. By 1926 considerable progress had been made and the quick-maturing Kenya Governor, a Red Egyptian × Equator cross, was available. Despite its susceptibility to four forms of stem rust this variety has been the major standby for the past 20 years at low and medium altitudes. It has always been popular with the millers and has been the chief variety grown in the Northern Province.

Several wheats from Canada, Australia and elsewhere have been imported for breeding work and for growing on commercially, but with few exceptions they have generally proved too susceptible to stem rust. So often new varieties with the best resistance have been unattractive to the miller. The very popular 192 is an example; a high-yielding, quick-maturing wheat for lower altitudes, resistant to all except one form of stem rust. During the war, however, two new hybrids were given a prolonged trial in Tanganyika, showed excellent rust resistance, were good millers' wheat and were taken into commercial production. More recently they too have shown signs of susceptibility to new forms of stem rust.

The story of wheat varieties in Tanganyika has been one of introduction of the chief varieties from Kenya as they have been proved, a period of enthusiastic production only to be checked by a sudden serious outbreak of rust, a loss of popularity and the introduction of still newer strains. The two exceptions to this rule are Kenya Governor and 192, maturing in about four months, although some heavy losses have

occurred with the former. At higher altitudes, yellow-rust-resistant Equator, 117A and Sabanero have been used successfully, taking about six months to mature.

Pests and diseases

There is no doubt that stem rust (*Puccinia graminis*) is the most important disease of wheat in Tanganyika Territory, followed by yellow rust (*Puccinia glumarum*) and leaf rust (*Puccinia triticina*). Serious crop losses due to stem rust have occurred from year to year, more particularly in those of higher rainfall. One or more forms may occur in the same year, and the intensity varies from year to year and with the varieties of wheat in use. The time of planting and the period of the plant's growth at which the attack builds up are important factors affecting the damage which may occur. Where soils are highly moisture-retentive, late planting will often enable the crop to escape serious infection. On the other hand, early-sown crops of susceptible varieties can be attacked so late in the plant's life, when the ears are well formed, that little damage occurs.

Yellow rust has rarely caused serious crop damage. Whereas stem rust will occur at any altitude, yellow rust only begins to be a danger above about 5,000 ft. Different varieties become susceptible at different altitudes and, whereas 192 shows considerable infection at 5,000 ft., 117A can be safely grown at 6,000 ft. There is considerable difference in the safe altitude limit between Kenya and Tanganyika; for example, Sabanero is considered safe up to 8,500 ft. in Kenya, but becomes heavily infected at 7,500 ft. in the Southern Highlands Province of Tanganyika.

Leaf rust is of general occurrence and, while it rarely causes serious loss of crop, it is most troublesome when it occurs at lower altitudes with low rainfall, or on poor soils. On good soils and with medium rainfall, the plant seems to be only mildly affected and it is difficult to attribute any loss of yield to infection. One or two varieties show some resistance, including Kenya Governor, and one of the new 261 strains shows outstanding resistance.

Bacterial Black Chaff and Glume-blotch (*Septoria modorum*) occur from year to year and are of relatively minor importance. So far, Take All has not been recorded in Tanganyika Territory, although it is known in Kenya.

Except for epidemic attacks by locusts or army worms, insect damage is not serious. Tenebrionid ground beetles and stinkbugs (*Cydnus spp.*) have caused local seed-bed losses. There is evidence that mechanical cultivation can reduce stinkbug damage. Aphids attack the crop heavily in drier areas in dry years, but it is difficult to assess their effect on yield.

The most serious pests of the crop in the area around Arusha are birds, particularly the Sudan dioch (*Quelea quelea*) and the red-headed dioch (*Quelea cardinalis*). These species are gregarious and vary in numbers enormously year by year. It is almost impossible to scare the birds effectively from any large field, and some farmers have given up wheat production recently because of this difficulty. In the Sudan these birds have been drastically and successfully attacked in their roosts by explosives.

Conclusion

Production is still well below the Territory's requirements and the wheat crop should remain an important one in the Territory's agricultural and general economy. It is so easily grown mechanically in suitable areas, that it is an ideal crop for increasing the cereal reserves of the country with a minimum demand for African labour. Suitable areas are, unfortunately, considerably restricted. It is possible that further areas may be proved productive in the Southern Highlands, probably with the aid of phosphatic fertilisers. But, at present, transport costs would seem to preclude the widespread use of fertilisers, and economic export is out of the question. Should the new railway now under survey be built, the whole picture would change and the province might well become a cereal exporter.

For the plant breeder and the agronomist there are plenty of problems to be solved before wheat production in the Territory can be considered, as far as any form of agriculture anywhere can be so considered, a really secure form of enterprise for the farmer. Nevertheless, with good husbandry and a careful choice of varieties, suitable areas for wheat do produce profitable yields.

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Farm Incomes in England and Wales

THE Farm Management Survey, carried out in England and Wales, provides a useful indication of the level of farm incomes and their trends from year to year. Results for the years 1944-45 to 1947-48 have been published* and the following account, based on these results, gives an idea of the financial picture of British agriculture during those years. Nearly 2,900 farms are visited each year by recorders of the Farm Management Survey, and these farms are classified into 72 groups, most of which coincide with more or less distinct type-of-farming districts. These type-districts are further classified into four main type-of-farming groups, grass, intermediate, arable and specialist, on which this account is based.

Tillage land and grass

In the grass group 26% of the land was described as tillage area in 1944-45; this was reduced to 19% in 1947-48 mainly as a result of the sharp drop in cereal growing. This trend was repeated to a lesser degree by the intermediate group. In the arable group, however, the tillage area remained about the same at two-thirds, and a high proportion of this was devoted to cash crops.

In the grass group the area under temporary and permanent grass rose steadily during the four years, as was to be expected after the war. Permanent grass accounted for rather more than half of the grassland acreage in the intermediate group, and 20 out of every 100 acres in this group were under temporary grass. About 35 out of every 100 acres of land in the arable group were under grass, but 14 of these were temporary leys; thus about 80% of the land can be classed as arable.

Net incomes

Net income is the balance of revenue over expenditure adjusted for difference between opening and closing valuations of live- and dead-stock. This averaged £820 per annum over the eight-year period 1940-41 to 1947-48, varying from £1,063 in 1941-42 to £531 in 1947-48 (a year of blizzards, floods and drought). The average for arable farms was £1,127, for intermediates £933 and for grassland farms £608. Well over half the farms of

*'Farm Incomes in England and Wales,' Farm Income Series No. 1, pp. 191, 46 tables. H.M.S.O. 10s. 6d.

more than 500 acres realised a net income of more than £800, although net income/acre fell with size of farm.

Farm revenue

Farm revenue includes all cash receipts such as receipts from sale of crops, livestock and machinery, government subsidies, etc., and also certain items of non-cash income, *e.g.* the value of produce and stores consumed on the farm and rental value of the farmhouse for which no direct cash payment is made. Farm revenue rose by 15% between 1944-45 and 1947-48 from £3,379 to £3,706 per farm. Grass-type farms averaged £1,500 less than the arable and intermediate, although in terms of per 100 adjusted acres* there was relative stability in revenue of grass farms. Milk sales made up only 7% of the total revenue of the arable group, whereas grassland farms derived 40%.

Small farms tend to be less diversified than large farms and concentrate on few enterprises, while large farms develop in many directions besides farming less intensively.

Farm expenditure

Farm expenditure includes the rental value of the farm if owner-occupied, payments in kind and unpaid family work, excluding that of the farmer and his wife.

During the four years expenditure grew progressively greater and excess of revenue over expenditure decreased in the grass and intermediate groups, but fluctuated considerably in the arable and specialist groups. Average expenditure for all farms during the period under review was as follows: Labour nearly one-third, livestock 15%, seeds and fertilisers 12½%, feeding stuffs 8 to 9%, rent 8 to 9%, machinery purchases 6 to 7%.

Labour outlay/100 acres was greatest in the arable groups. The cost was less heavy on small farms, but this did not include the value of work put in by the farmer and his wife. If this is included the cost/acre is greatest on small farms. The average labour force for all farms is two to three men and one youth, woman or girl; this is equivalent to 15 or 16 men, three youths and four women or girls on every 1,000 acres.

The average rent per adjusted acre rose from 24s. in 1944-45 to 26s. in 1947-48; the increase was most marked in arable areas. These average figures, however, should not be taken as being very typical because there were wide variations from 10s. to 65s. per adjusted acre.

Expenditure on machinery was again greatest in arable areas. The average amount spent per 100 acres for all farms rose from £76 in 1944-45 to £175 in 1947-48. Repairs (including renewals) rose from £58 to £84 per 100 acres in the four years. This figure, together with annual depreciation, represents the total cost of machinery upkeep, which averaged £165 per 100 acres in 1947-48. Average costs of fuel and contract work respectively were £78 and £43 per 100 acres in 1947-48.

Expenditure on machinery, repairs, insurance and taxes, fuel and contract services accounts for 15 to 20% of total expenditure per 100 acres each year.

Net output

Net output is the amount remaining after purchases of livestock, feeding stuffs and seeds have been deducted from total farm revenue (other than that from sale of machinery and equipment), adjusted for difference between opening and closing valuations of livestock and crops. This can be used to measure productivity in terms of per £100 expenditure, per £100 rent or per £100 labour. Over the four years the averages were £128 per £100 expenditure, £1,120 per £100 rent and £238 per £100 labour.

Valuations

In each year except 1944-45 the closing valuation for the whole sample of forms exceeded the opening valuation.

R.G.P.

*The area under rough grazing is expressed in terms of equivalent acres of crops and grass; thus, in the Lincoln Wolds two acres of rough grazings are equivalent to one acre of pasture, but in East Westmorland the ratio is roughly five to one.

Photo above: Ford Motor Co.

During 1944-45 to 1947-48 tillage land on arable areas has remained at about two-thirds; in grassland areas the sharp drop in cereal growing has reduced the tillage land by about a quarter

Sugar Industry in Israel

Funds from the recent 35 million dollar U.S. Export-Import Bank Loan will help to establish a complete sugar processing factory in Israel. It is expected that this factory will, within three or four years, supply Israel's entire sugar requirements.

The bank has approved the allocation of $600,000 to Hamashbir Hamerkazi for the purchase of machinery in the United States. Hamashbir will invest a sum greater than that allocation and will set up an industry that exists nowhere in the Near East, outside Egypt.

If delivery conditions are satisfactory it is expected that the initial phase of production will begin within one year. This will be the refining of raw sugar imported from abroad, probably from South America and Cuba.

When additional funds are available the plant will be expanded so that locally-grown sugar beet and sugar cane can be completely processed at the rate of 150 tons a day. Israel now consumes 30,000 tons of sugar per year and spends four million dollars a year on this item of import.

Hamashbir will construct its plant not far from the railroad line near Yavne. Sugar crops will be raised in the surrounding region—sugar beets in the immediate vicinity and sugar cane around Migdal Gad, south of Yavne. About 35,000 dunams (1 dunam = ¼ acre) of land per year will be required for the crops.

The factory will employ about 150 workers in the first stage of its development and subsequently double that number.

The Mineral Nutrition of Crops

With Special Reference to Fruit Crops

Part I

Prof. T. WALLACE, C.B.E., M.C., D.Sc., F.R.I.C.

Director, Long Ashton Research Station, University of Bristol, England

The problems of crop nutrition are obviously of importance to all horticulturists and agriculturists. The following paper by Professor Wallace is the substance of his Cawthron Lecture delivered at the Cawthron Institute, Nelson, New Zealand, during his recent visit to that Dominion. It contains a review of our present knowledge of this subject and was originally published as a bulletin of the Cawthron Institute. It is reproduced in WORLD CROPS *in two parts, the second of which will appear next month.*

IN presenting a general picture of the main practical problems concerned with the mineral nutrition of crops it is necessary to discuss three points:

1. Essential and beneficial elements for plant growth.
2. Effects of essential elements on plants.
3. Problems concerning the supply of mineral nutrients to plants.

Essential elements for plant growth

So far 12 elements have been proved to be essential for the growth of plants. This list is not regarded as a final one; there may be many more to be added, but it can be stated with confidence that any others will be required only in very small amounts and very refined experimental methods will be necessary to prove them to be essential.

Professor D. I. Arnon has suggested the following criteria of essentiality for mineral nutrients: (i) The element is necessary to complete the full growth and reproductive cycle; (ii) it cannot be completely replaced by any other element for these functions; (iii) its action on the plant must be direct.

The 12 elements at present regarded as essential are usually classified into two groups:

(a) *Major or macro nutrients*, these being the elements required by plants in relatively large amounts. This group includes nitrogen, phosphorus, calcium, magnesium, potassium and sulphur.

(b) *Minor or trace elements or micro nutrients*, which are those required in relatively small amounts. This group is comprised of iron, manganese, copper, zinc, boron and molybdenum.

The grouping into major and minor does not indicate in any way the relative importance of the elements as nutrients for plants, and it must be realised that the elements in group (b) are equally important to the plant as those in group (a). Thus a complete lack of any one of the elements will result in a complete failure in plant growth, and this statement holds also for our economic crop plants. Moreover, deficiencies of each of these essential elements are known to occur under practical farming conditions and to result in serious crop losses. Thus, deficiency of molybdenum, the last of the elements to be proved to be essential, has already been shown to be the cause of failures in cauliflower and legumes (clover and peas) and this despite the fact that the amount of the element required for healthy growth is only of the order of one or two ounces per acre.

Apple tree, variety Sweet Alford, 13 years old. The tree has become deficient in magnesium and is unable to ripen its crop because of severe defoliation

The elements referred to as beneficial are those which have been found to increase the yields of certain plants or to help indirectly in growth processes but which so far have not been proved to be essential. This group includes sodium, chlorine, silicon, aluminium and nickel, and of these the best known example in practical agriculture is the beneficial effect of sodium for crops such as sugar beet and mangold.

In addition to essential and beneficial elements other elements often occur in plants, which produce no known beneficial effects and indeed some of these may be harmful.

The effects on plants

The main effects produced by each of the essential elements can be shown by growing the plants under conditions of deficiency for each element, either in sand or in water culture fed entirely by chemical salts containing the essential elements. The particular nutrients for which the effects are to be tested are omitted one at a time from the respective nutrient solutions. Results obtained by this method have been subsequently checked in field crops both on experimental plots and on farms.

The following are some of the most important effects produced in crops by deficiencies of the respective elements.

Nitrogen. Shoot growth is small and the shoots are relatively few, thin, upright

and stiff; tillering and lateral growths are poor; the amount of foliage is small and the leaves pale or yellowish green, and when mature they develop high tints of orange, red or purple; defoliation is premature and begins at the oldest leaves; flower bud formation is reduced and the buds open late; fruit, grain and tuber formation are poor; fruits are generally small, highly coloured, sweet or woody to taste and store well; the barks of trees are often light or reddish brown.

Phosphorus. The effects are in many ways similar to those resulting from nitrogen deficiency. Thus shoots are small, thin and upright, tillering is poor and there are few lateral growths. The leaf characters, however, may differ markedly from those of nitrogen deficient plants: colour may be bluish green with dull purple tinting or the older leaves may develop marginal scorching, as in potato, or brown spotting, as in clovers and black currant. Flower bud formation, fruiting and grain and tuber formation are poor and flowers open late, all these points again resembling nitrogen deficiency effects. Fruits, however, are soft, of variable appearance, markedly acid and often unpleasant to taste, and are of low commercial value.

Calcium. Unlike nitrogen and phosphorus (see also magnesium and potassium) the effects of calcium deficiency are mainly evident at growing points such as the tips of shoots and roots, and become progressively more severe at these points as the plants mature. Other outstanding effects are collapse of leaf margins or mesophyll tissues, wilting of shoots, petioles of leaves and flower stalks. In tomato plants flower trusses die back from the distal flowers and fruits become affected with blossom-end wilt. Potatoes fail to form tubers and roots are always poorly developed and lacking in fibre.

Magnesium. The main effects of magnesium deficiency are shown in the leaves and in premature defoliation. The leaves may be chlorotic or they may develop characteristic tinting patterns, either between the veins, when the margins may remain green, or around the margins when the effects may progress towards the leaf centres; sometimes the chlorotic and tinted areas subsequently become necrotic or necrosis may develop without previous tinting. The older leaves are always first affected and the symptoms may spread rapidly to the younger leaves. Affected leaves defoliate prematurely and defoliation may occur very suddenly and be of serious consequence, as in fruit trees, on which the fruits may fail to ripen and remain immature and woody.

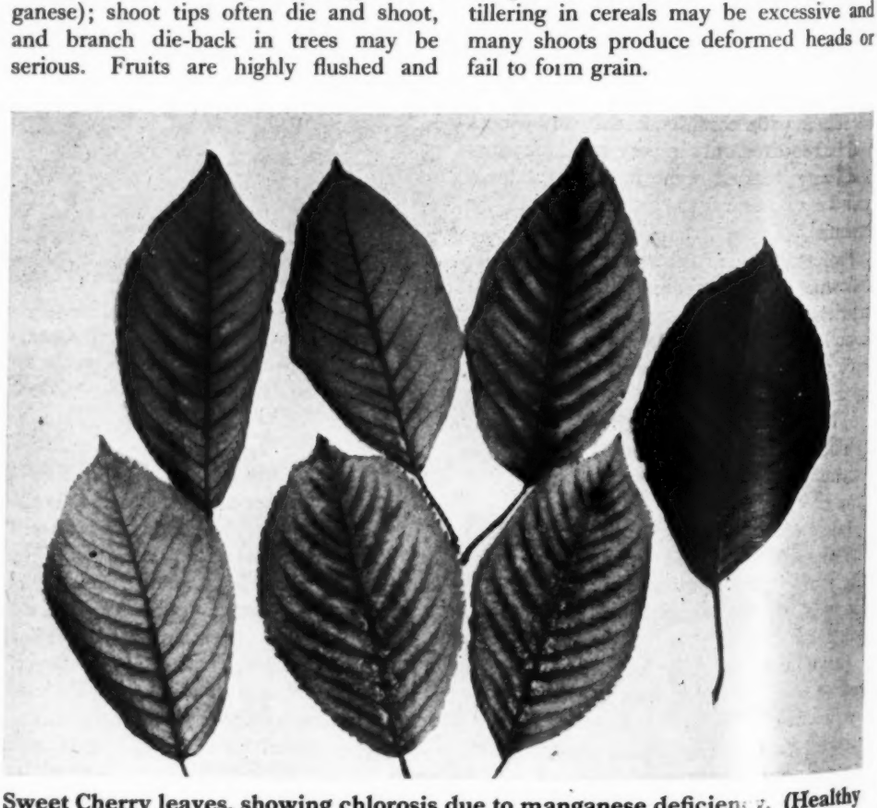
Potassium. In the early stages shoot growth is dwarfed and the shoots are thin, but later the internodes become progressively shorter and the plants appear squat; in fruit trees die-back is prevalent in acute instances; leaves may be bluish green or somewhat chlorotic, and the margins or tips usually die and turn brown or greyish brown (leaf scorch); on some plants (clovers and potato) the leaves develop characteristic spotting patterns in addition to marginal effects; flowering is not greatly reduced in the early stages and lateral shoot development (*e.g.* tillering) may appear excessive; flowers tend to open early and fruits may set heavily, but they drop excessively and cropping is poor; fruits remain small and useless, colour is variable and ripening delayed; the texture is generally woody and flavour subacid and sweet.

Sulphur. The effects of sulphur deficiency are generally similar to those of nitrogen deficiency, leaves being small and pale green and tending to develop bright tints.

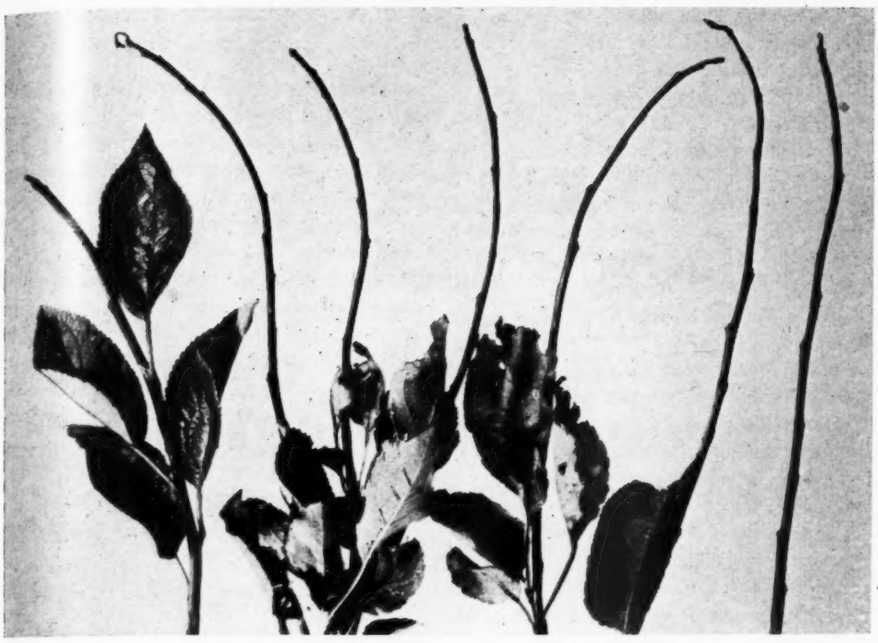
Iron. The characteristic effect of this deficiency is chlorosis of the young leaves at the tips of shoots, the chlorotic condition decreasing progressively down the shoots; the chlorosis generally assumes a well-defined pattern over the leaf surface, in which the small sub-lateral veins can be clearly seen in the early stages (*cf.* manganese); shoot tips often die and shoot, and branch die-back in trees may be serious. Fruits are highly flushed and have a chlorotic ground colour, but quality may be poor due to low content of sugars.

Manganese. This deficiency produces a number of different kinds of effects on different types of crops. One of the most common of these is chlorosis of the foliage, which can usually be easily distinguished on fruit trees from chlorosis due to iron deficiency by two characters: (1) the effects for manganese are not usually most severe on the young leaves at the tips of the shoots but on older leaves; (2) the chlorosis begins near the margins of the leaves and progresses intervenally in a V-shaped pattern towards the midrib; as for iron, the chlorosis may be followed by die-back of shoots. On Brassicae the chlorosis develops as an intervenal mottle and it may be impossible visually to distinguish between chlorosis due to iron and manganese. On some crops—potatoes and beet—characteristic lesions or spots are developed on the leaves, and on peas and beans the flat surfaces of the cotyledons of the seeds show characteristic brown lesions (Marsh Spot of peas).

Copper. The main effects of this deficiency are produced at growing points which either fail to develop or die back; leaves may be dull, bluish green or chlorotic. In fruit trees, shoot and branch die-back may be accompanied by gumming and deformed swollen growths; tillering in cereals may be excessive and many shoots produce deformed heads or fail to form grain.



Sweet Cherry leaves, showing chlorosis due to manganese deficiency. (Healthy green leaf for comparison on right)



Terminal shoots of apple showing typical method of defoliation and shoot die-back caused by copper deficiency

Zinc. Shoots are dwarfed and internodes very short; leaves are small and narrow and when crowded, due to the short internodes, produce on trees characteristic ' rosette ' effects; foliage may show a marked mottled chlorosis, as in citrus species (mottle leaf), or intervenal chlorotic patterns.

Boron. When boron is deficient the differentiation of meristematic tissues is incomplete and results in the death of growing points and the deformation of developing tissues. A large number of characteristic effects are produced on different crops and many of these have been given descriptive names by growers, *e.g.* ' brown heart ' or ' crown rot ' of sugar beet, ' canker ' of table beet, ' hollow stem ' and ' curd browning ' of cauliflower, ' cracked stem ' of celery, ' brown heart ' or ' raan ' of swedes and turnips, ' top-sickness ' of tobacco, and ' drought spot,' ' cork ' and ' corky core ' of apples. It should be noted that many crops when affected by this deficiency are useless.

Molybdenum. As molybdenum has only recently been shown to be essential for plant growth its effects on many crops are not yet known. It appears to be particularly important for Brassicae and legumes. Deficiency effects for the former take the form of death of growing points, chlorotic mottling of the leaves, cupping of leaves (savoys), failure of leaf laminae to develop (whiptail condition of cauliflower); flower stems may wilt. On tomatoes leaves become chlorotic and margins roll forward. Other plants show death of marginal tissues of the leaves; legumes (clovers) may show nitrogen deficiency effects due to failure of the nodule organisms to fix this element.

The effects of excesses

Methods similar to those used in determining deficiency effects can be employed to determine the effects of excesses of essential and other elements.

Manganese. The effects of excess of this element may resemble those due to deficiency of it. Foliage may show chlorotic mottling (sugar beet, runner and dwarf beans) or spotting and brown lesions (potato); other leaf effects include lateral restriction of laminae, incurling and necrosis of margins (Brassicae) and discoloration of veins (potato); petioles and stems may develop lesions (potato and tomato) with subsequent collapse and drying out of leaves. Excess of manganese may induce a deficiency of iron (see below).

Aluminium. The above-ground portions of affected plants have the appearance of phosphorus deficiency and the inducing of this may, in fact, be an important effect of this excess. The roots are poorly developed, appear swollen and ' stubby,' and lack fibre.

Chlorine. Toxicity of chlorine often produces a brown marginal scorching of the leaves which may be confused with potassium deficiency. This feature is especially marked in the red currant. Shoot growth, however, is more normal than for potassium deficiency and internodes are not shortened.

Boron. Common effects are marginal and intervenal scorching of the older leaves. In citrus the leaves may show irregular orange-coloured areas, and small, raised brown spots resembling gum pockets occur on the under-surfaces of the tinted areas.

Heavy metals (copper, etc.). These metals all produce severe chlorosis and intervenal necrotic patterns. The chlorosis may be largely or wholly the result of induced iron deficiency.

The supply of mineral nutrients

In practical agriculture the problems of the supply of mineral nutrients to crops concern both yield and quality, and it is important to recognise that high yields and high quality are not always attained by the same treatment. Thus, in the case of dessert apples, the highest yields are likely to result when the nitrogen level is relatively high and the highest quality when it is relatively low. With the black-currant crop, however, high yields and high quality run parallel and there is no question of sacrificing yields to obtain the highest quality. These relationships can only be learned by experience, and the best results will only be obtained by an understanding of the special effects of the individual elements and their interactions on growth.

There are, of course, many problems concerned with the supply of mineral nutrients to crops, but three points only of special practical importance are discussed:

(1) The mineral status of crops.

(2) Some soil conditions affecting supplies of mineral elements to crops.

(3) Particular requirements of different crops for mineral nutrients.

The mineral status of crops

The main problems of mineral status concern deficiencies and excesses of the mineral nutrients and their inter-relationships, often referred to as nutrient balance or interactions.

Deficiency problems relate to critical levels of the respective nutrients within the various organs of the plants to produce vegetative growth, flowers and fruits. The ways in which these processes are affected by deficiency levels of the individual elements have been described previously. In practice the nutrient elements may continue to increase crop yields at levels well above the critical levels for ' minimum functioning ' and hence mineral deficiencies may be said to exist until the highest yield points are reached, *i.e.* points above which yields cannot be increased by the further application of mineral nutrients.

Deficiencies may exist either as single or multiple deficiencies and when elements are present at very low levels they may act as limiting factors to growth, *i.e.* growth will not be increased except by raising the levels of the particular elements. Or, as often happens in field crops, the increase in level of one element may render the level of another relatively low and this is the reason why the highest yields are frequently obtained by the use of the so-called complete manures or fertilisers.

Two possible effects may result from the presence of excesses of mineral nutrients. The plants may merely absorb unnecessary amounts of the elements without any effect, either beneficial or harmful, resulting. Such absorption is sometimes referred to as luxury consumption and may occur to some degree with all the essential elements, but more particularly with those comprising the major group, especially potassium. In the case of the minor or trace elements the range of luxury consumption is usually narrow and even quite small excesses may be harmful.

The other main effect of excesses is to produce damage and the nature of the harmful effects is sometimes characteristic for individual elements. (See earlier note for manganese, etc.) It should be noted that in extreme instances total failures of crops result from excesses.

Nutrient balance and interactions

To produce healthy growth it is essential that the nutrient elements should be present in the various organs of the plants not only in sufficient quantity but in fairly well-defined proportions. This balanced condition is very important in the growth processes, in the course of which the individual elements interact. In these certain elements appear to oppose each other in action whilst others seem to help one another. Thus it is possible to regard the relationships between elements as either antagonistic or beneficial, and research has shown that such reactions occur both in connection with the absorption of nutrients by the roots and with processes within the plant (*e.g.* translocation). Antagonistic effects are most pronounced when the difference between the levels of the elements is large and indeed, when the levels are similar, the effects may disappear entirely and the elements appear to become mutually beneficial in increasing vegetative growth and crop yields.

The principal known antagonisms and beneficial effects are shown below.

Antagonisms: N/P; N/K; K/Mg; Mg/K; P/K; N/Ca; Na/Ca; K/Ca; Mg/Ca; Ca/Mn; K/Mn; Mn, Cu, Zn, Cr, Co, Ni/Fe.

Beneficial effects: N/Mg; K/Fe.

These interactions are very important in field crops and a knowledge of them will not only explain many seemingly curious results with fertilisers but will often enable substantial economies to be made on manures. Thus, we may take as a practical example that of magnesium deficiency in tomato crops: in this instance the trouble will often be greatly decreased by dressings of nitrogenous fertilisers, or may be substantially increased and control measures rendered ineffective by heavy dressings of potassic manures.

A knowledge of the seat of the reactions is also of importance in practice. Thus potassium and magnesium show strong antagonistic effects and these are pronounced in connection with absorption. In experiments on magnesium deficiency in fruit crops and tomatoes it has been a common experience to find that the trouble is associated with high levels of available potassium in the soil. Control of the deficiency in such instances by soil applications of magnesium sulphate has proved very difficult and slow, whereas by the use of this material in foliage sprays the deficiency has been quickly remedied by relatively small quantities. Thus for tomatoes soil dressings of 1 ton per acre of agricultural Epsom salts have sometimes produced only moderate responses, whereas 3 to 5 cwt. of the material applied as foliage sprays, at 2% strength, have completely cured the trouble and restored yields to high levels.

In the case of potassium/iron relationships, in which potassium has a beneficial effect on iron, a different picture is presented. Thus, in sand cultures, we have grown a series of potato plants at a very low level of iron in combination with three levels of potassium which may be designated low, medium and high. At the low level dwarfed plants were obtained that showed marked symptoms of iron deficiency in the young growths and acute signs of potassium shortage in the older leaves. Plants receiving medium potassium grew better but still showed the iron deficiency symptoms in the young growths. In the high potassium plants growth was very vigorous and the only evidence of low iron status was the slightly pale green colour of the leaves and a slightly chlorotic condition of the oldest leaves, from which it appeared that under the high potassium conditions the limited supply of iron had been efficiently translocated to the young leaves and utilised effectively for growth purposes.

(*Part II of this article will appear in the June issue.*)

Photos: Long Ashton Research Station

U.K. Fertiliser Production Increasing

Production and consumption of sulphate of ammonia in the U.K. has been increasing steadily during the past few years to reach a record value last year, according to the annual report for 1949-50 of the British Sulphate of Ammonia Federation Ltd. Actual production of the fertiliser (nitrogen content varying from 20.4 to 21.1%) amounted to 924,500 tons in 1949, compared with 901,000 tons in 1948, 796,700 tons in 1947 and 483,300 tons in 1939. Home agricultural consumption has increased considerably to a total of 748,115 tons for the fertiliser year 1949-50, compared with 179,700 tons for 1938-39. Although production has doubled over the past ten years, domestic consumption has increased four-fold.

Water Utilisation Scheme for Northern Rhodesia

At the invitation of the Colonial Office two American engineers are visiting Northern Rhodesia to explore the possibilities of increasing food production by utilising flood waters of the Kafue River for rice cultivation. The survey is being sponsored by E.C.A. and the Colonial Office.

During the next eighteen months they will be working on the project with the Northern Rhodesian Water Development and Agricultural Departments. They will provide specific advice on the amount of water likely to become available in the area and on the possibility of growing rice by using residual flood water without resorting to any large-scale engineering works for controlling the water.

Leaf Scald in British Guiana

Mr. P. O. Wiehe, plant pathologist of the Government of Nyasaland, is to be seconded to British Guiana for six months to carry out research on the pathology of the leaf scald disease which has recently been discovered on the sugar estates there. The cost of Mr. Wiehe's visit is being shared equally between the British Guiana Government, the sugar industry in British Guiana and a grant made under a Colonial Development and Welfare Research Scheme.

Leaf scald is a bacteriological disease of extreme virulence which causes the sugar cane to wither and reduces its yield of sugar by 50% or more. It has previously been reported from sugar growing areas in Mauritius, Queensland and Hawaii, where it was eventually brought under control by breeding resistant strains and enforcing plant hygiene measures. It has not previously been reported in the West Indies.

Rice Research in South-East Asia

AN international co-operative rice research project under the auspices of the Food and Agriculture Organisation is being carried out at the Central Rice Research Institute at Cuttack, India. Eight other rice-growing countries are participating with India in a hybridisation scheme which is aimed at improving the rice crops of this and other producing areas by a programme of breeding, selection and seed exchange which has been worked out on an international basis.

Other important rice research work being carried on at the Institute for the improvement of quality and productivity in rice growing is designed to benefit India's national agricultural plans as well as the economy of the whole of South-East Asia, where rice forms the staple food of a very large percentage of the population.

Work of the Central Rice Institute

The Institute was established by the Government of India in September 1946 at Cuttack, which is 180 miles south-east of Calcutta and lies in the main rice-growing tract of India, where it occupies an area of 250 acres. It carries out both short- and long-term programmes of research. It has also begun, to a limited extent, to provide training facilities for research workers from other South-East Asian countries.

Among the practical experiments the Institute has carried out and demonstrated, are the growing of two rice crops in a season in the canal-irrigated areas of India. The varieties suitable for the second crop and the optimum time of planting it have been determined. Studies have been carried out on the comparative merits of various fertilisers as well as the best methods and times of application.

Breeding for resistance to two of the most important diseases of rice (blast and leaf spot) is a major field of study—the susceptibility of nearly 800 rice varieties has been tested. Experiments relating to pests affecting the grain in storage are also being carried out, and very encouraging results have been obtained in treating seed against them.

The Institute farm is supplying pure nucleus seed of all improved varieties of rice to the Orissa Department of Agriculture for use in India's Grow More Food Campaign. The Institute is also working out the comparative economic use of small hand-worked and power-driven machinery introduced from Japan that can be used in the cultivation, harvesting and processing of rice.

Terraced rice padis in Shizuoka Prefecture, Honshu, Japan

Hybrid rice breeding programme

Paddy cultivation in the whole of South-East Asia (where relatively low yields are generally obtained) is expected to benefit from the hybridisation scheme which was launched at the Institute in 1950. The programme aims at combining the high-yielding quality of the round-grained japonica rice with the adaptability of the long-grained indica type to the varying climatic and soil conditions and cultural practices of the Indian sub-continent and South-East Asia.

The rice-growing countries have sent seed of the most important varieties of each group to the Institute, where they have been planted as the basic material from which the crosses can be made. After the seed from the crosses is harvested it will be sent for testing to the countries from which the parent stocks were received. In addition to producing the first generation hybrids, the Institute at Cuttack will distribute the seed of the second generation to other rice-breeding stations participating in the project. This project was recommended by a Rice Breeders' Working Party which met at Rangoon in February 1950, attended by rice breeders from the following countries: Burma, Ceylon, India, Indo-China, Indonesia, Japan, Malaya, Thailand and the United States. Egypt and the Philippines were also represented.

Collection of stocks

Another important service to rice-growing countries carried out at the Institute, in co-operation with the F.A.O., is the maintenance of a large collection of rice genetic stocks. Over 3,000 genetic stocks have been collected and specimens are being sent to many rice growers in different parts of the world. The Institute has also become a central point for the collection and dissemination of authoritative information on rice research methods.

Photo, U.S.I.S.

WORLD CROPS

OUR NEXT ISSUE will include an article by Colin Maher, on the **development of soil conservation technique in arable areas of Kenya**; the author was the Senior Soil Conservation Officer for that Colony. Dr. C. de Fellner, recently returned from Greece, has contributed an article on **some problems of agriculture in Greece.** Part II of D. P. Hopkins' **new ideas about soil fertility** will appear and also the concluding part of Professor T. Wallace's Cawthron lecture on the **mineral nutrition of crops.** Besides these, there will be other articles and regular features as usual.

Mechanisation of Native Agriculture in Tropical African Colonies

A number of articles have already appeared in the pages of WORLD CROPS *on the important problems of mechanising tropical peasant agriculture. The recent publication of a report on this subject by the Colonial Office is, therefore, particularly interesting.*

THE urgent necessity of increasing the production of foodstuffs to feed the vast under-nourished populations in tropical countries, and of improving their economic conditions, has directed attention to the possibilities of mechanised farming in these regions. Of particular interest, therefore, is the Report of a Mission* charged with the survey of sociological, economic, agricultural and technical problems which need to be studied if mechanisation in the Colonies is to develop on sound lines. The mission visited selected areas in Uganda, Tanganyika, Nyasaland and Nigeria, and their report therefore, is concerned essentially with these territories ; the problems in other tropical regions may, however, be basically similar, differing only in proportion and detail and, accordingly, the findings can have a much wider application.

The Mission decided that in tropical Africa the savannah zone, with its pronounced wet and dry seasons, is the most suitable for mechanisation. Scrub country of low rainfall is more suited to cattle ranching, though mechanisation for water conservation and on irrigated lands is possible. Regions of heavy and well distributed rainfall are better suited to perennial crops, and where the population is not too great, to stock farming. In planning the introduction of tractor cultivation, the influence of density of population on the size of farms and the systems of farming and livestock husbandry, including the use of draft animals and the provision of animal manure, must be taken into account. Moreover, animals are particularly important in the economy of the farm, since they form a valuable reserve of food and capital.

Conditions in savannah areas

Over most of the savannah areas, the Africans are caught in a vicious circle of malnutrition and disease, resulting in a low capacity for work. There is, therefore, inadequate food production. Furthermore, there is a tremendous wastage of labour in domestic work, such as carrying water, milling grain by primitive means, and the transport and sale of produce. The area of farms could be increased with great advantage and the 'pioneer fringe' be pushed further back if domestic processing and marketing were reduced. The Mission considered that the introduction of mechanisation would afford opportunities to increase the efficiency of labour, and to use more fully and wisely the resources of soil and water ; but mechanisation is unlikely to succeed where systems of agriculture have not developed beyond the stage of satisfying the need for food for domestic needs and for sufficient cash for payment of taxes.

Types of mechanisation

The following are considered the types of mechanisation which would have the most effect on farming systems and on productivity : earlier planting and weeding, easier clearing of land and breaking of fallow for tillage, cultivation of certain difficult soils, after-cultivation and weeding, control of pests, soil conservation work, provision of water supplies, grain milling, transport, and better tools and other simple mechanical aids. Mechanical cultivation might provide a stimulus both to Africans and their advisers to speed up improvements the value of which is sufficiently proved on both technical and economic grounds ; in many savannah localities the various attendant services to mechanisation would bring about major developments on a broad front in agriculture and animal husbandry. It is evident, however, that special administrative and advisory services must be provided if implements are to be wisely and fully used.

Limiting considerations

The rapid increase of human populations in some areas and demands for better nutrition are long-term considerations, difficult to measure ; nevertheless, they are highly significant when the economic value of increases in the productivity of land or of the control of soil erosion have to be assessed. The comparatively rapid increases in productivity over small areas which mechanisation might make possible could be largely offset by rapid increases in population ; in such a case the capital and skill devoted to mechanisation schemes for a few localities would add but little to the food supply per head. Further, where the supply of labour is high in relation to the supply of land, mechanisation will not be economic ; it is also doubtful whether it will be economic where insufficient land is available to permit expansion of the tillage area farmed per household.

Experience in mechanisation in native areas is as yet inadequate, and insufficient technical and costing data are available on which to base reliable comparisons of mechanical systems with existing native methods. Practical trials on an adequate scale are, therefore, a prior necessity. Undoubtedly, the cost of mechanical cultivation would be high, due in part to the size and shape of fields and to obstructions such as ant hills and stumps, and one must, therefore, look for higher yields to compensate for higher costs of production. There is, however, every likelihood that higher yields would be obtained, for the present main limit to crop production is the difficulty of completing in good time the initial preparation of the land. Earlier completion of cultivation by mechanical means and other possible improvements should therefore result in higher yields. Full-scale mechanisation is not, however, necessarily the most economic form ; rather should mechanisation supplement and not replace the hoe, while its use to save labour is only economic if the time thus saved can be put to better use.

Need for a changed outlook

The pressing desire for greater material wealth and improved social services cannot be satisfied unless great changes are brought about in the use of the land and livestock, and in the efficiency of labour, but such changes are impossible unless the natives are given clear guidance and growing faith in their own ability to control these material environments. Mechanisation, if wisely introduced, may foster such faith in many cases.

* Report of a Survey of Problems in Mechanisation of Native Agriculture in Tropical African Colonies. Colonial Advisory Council of Agriculture, Animal Health and Forestry. Publication No. I. Pp. 121. Illustrated. 2 maps. H.M. Stationery Office, London. 1950. 4s. 6d.

Half-track Fordson and two-furrow mouldboard plough after short weed fallow. Serere, Teso. Two tractor drivers and runner

Cotton maize rotation making mechanical hoeing impossible, but good as an anti-erosion measure. Bugunda

Typical hillside cultivation, Bugunda. Note tree and ant-hill obstructions in plots

Characteristics likely to foster acceptance of mechanisation are leadership, a co-operative attitude towards authorities and towards work, willingness to consider the future and to conserve and accumulate capital, and a desire for increased productivity. In very few areas are these social attributes prevalent. The African native usually lacks training and experience needed to run a small business, and his loyalties are directed rather to individuals than to organisations. Resistance to mechanisation is possible because to some it will be obvious that social customs will be upset by it. The soundest policy might therefore be to encourage economic development as rapidly as is acceptable to the people themselves and in most areas to use every opportunity that offers to strengthen the hands of and give additional responsibilities to native authorities and social groups.

Land tenure problems

Land tenure problems are an inevitable product of economic and social developments which would generally be aggravated by the introduction of mechanisation. In districts of low population, under shifting hoe cultivation, the value of land is equal to the labour spent on it. Improvements of crops, transport, and administration raise productivity and therefore the demand for land is increased. Comparatively rapid increases in productivity over small areas which mechanisation would make possible would be offset by economic and social forces. It is therefore essential that not only education and social changes should proceed sufficiently rapidly along with mechanisation, but that land tenure arrangements should provide safeguards against the creation of too many holdings and fragmentation. An early and definite policy is necessary to safeguard the future. Security of tenure is the surest basis on which to encourage improvements, while to prevent abuses, all land should be vested in a fully competent public authority.

Collective farming

The Report discusses the pros and cons of collective farming and concludes that the disadvantages outweigh the advantages. It is considered that in sparsely populated areas there should be a grouping of such of the lands of individuals as are to be mechanically cultivated, to facilitate the use of machinery while retaining the advantages of family farming. In areas of good soil with moderate densities of population simple services might be provided, such as tractor ploughing, provided by special contracting units, either by co-operatives, private or public firms.

Mechanisation is likely to be restricted less by machinery problems than by agricultural, economic, and social conditions. Machinery problems include the selection, trial, and adaptation of machines suitable for local conditions, the building up of adequate supply and repair services and the training of the operative personnel. In general the present machines are suitable, but careful assembly and proper dissemination of existing machinery is necessary.

The use of tractors

Broadly, there are two main uses for tractor power ; agricultural work and civil engineering work such as the construction of dams, roads and bush clearing. Whereas agricultural work requires general purpose tractors capable of any operation from ploughing to row-cropping, civil work requires heavy tractors which are too high-powered and too difficult to manoeuvre for normal farm work. During the early stages of mechanisation, however, the demand will be largely for heavy tractors to open land, and it may therefore be possible to carry out the two types of work with one class of machine. An increase in mechanisation is likely to extend the need for machines to combat soil erosion, and it seems possible that in time civil requirements will develop away from the agricultural ones. It is unlikely that this full-scale mechanisation will be reached for many years. At present the area the cultivator can prepare for planting is the limiting factor in ' pioneer fringe ' areas. As soon as this is effectively mechanised, the limit will be the amount a farmer can hoe, and finally it may become the area that can be harvested.

A machine advisory bureau

The Report discusses the types of machines required *vis-a-vis* types of work to be done. It is considered that there is urgent need for provision to make authoritative advice freely available to all concerned ; to achieve this it is suggested that in addition to inter-departmental exchanges of information, a special agricultural machinery advisory bureau should be set up in England to deal with enquiries from the Colonies, to answer questions on types of machines likely to suit particular requirements and the types available. In addition, the bureau would collect and collate the results of experimental work, and assist Colonial officers to become acquainted with machines available. In other words, the bureau would become a clearing house for information and enquiries and would also maintain close

liaison with manufacturers and research workers in the United Kingdom.

The Mission considered the major problems which needed study during the next few years, including the organisation of experimental trials and research. It concluded that the next few years should be utilised in building up knowledge to serve as a basis for later developments. Additional information is vitally necessary on farm budgets and organisation ; on technical aspects such as the characters and distribution of soils, the prevention and control of soil erosion and the maintenance of fertility ; on plant breeding, animal husbandry and pasture management ; on machinery trials, as well as on social and sociological conditions and on land tenure problems. The assembly of this varied and detailed data would be accelerated if all the experts and administrators concerned had a clear conception of the co-ordinated body of knowledge required and of the practical purposes it is to serve. Full and early discussions in these regards are, therefore, obviously desirable.

Photos taken by Mr. J. W. Y. Higgs, one of the members of the Mission.

1923 Fordson and disc plough broken down. Bought by farmer against advice of the Agricultural Department. Bukalasa, Bugunda

New Ideas on Soil Fertility

Part I

D. P. HOPKINS, B.Sc., F.R.I.C.

In the first part of the paper which appears below, Mr. Hopkins discusses the results of Ingham's recent work on nitrogen fixation. In Part II, which will appear next month, he deals, among other things, with some recent results of research into the problem of phosphate fixation.

PICKING out new ideas is essentially a matter of personal opinion, and it is equally a personal opinion that in 1950 two notable new ideas concerning the processes which determine fertility appeared in two published papers. The earlier of these presented evidence of the existence of a hitherto unappreciated factor in the fixation of available phosphates in the soil, while the later paper developed a new conception of the natural processes whereby supplies of nutrients are continuously replenished in soils. As the later paper has a more general bearing it is considered first.

Fertility and the atmosphere

The paper in question is by G. Ingham[1] and is a contribution of South African origin. Its title is ' The Effect of Materials Absorbed from the Atmosphere in Maintaining Soil Fertility.' In it he puts forward the view that the atmosphere is a very dilute but appreciable supplier of plant nutrients, the materials being absorbed by colloidal organic matter and subsequently washed into the soil by rain. He considers that the principal absorbing agent is cellulose and in his investigations he hung strips of a form of pure cellulose (acid-washed Whatman's filter paper free from nitrogen and soluble mineral matter) in the air for various periods, protecting them from rain. By appropriate chemical methods he showed that appreciable amounts of nitrogen in the ammonia form were absorbed during these exposures, the amounts absorbed expressed as ammonia being :

	One day	*Two days*	*Three days*	*Seven days*
Ammoniacal N absorbed as mg./sq.cm.	0.15	0.23	0.28	0.41

After washing out these absorbed amounts and drying the papers, further exposures gave the same or closely similar results. Pre-acidification of the paper (with dilute HCl) trebled the absorption capacity; a pre-treatment with dilute alkali reduced the capacity by 50%.

Further tests were then made with natural cellulosic material. Highly fibrous materials resistant to micro-organic attack were exposed to the atmosphere in an air-dry state, dried grass, jute fibre, sisal fibre and wood fibre (sawdust and shavings) being used; under such conditions, increases in their contents of soluble nutrients could not be attributable to bacterial decomposition. He found that exposure to the atmosphere produced appreciable absorption in all cases, not only for ammonia-N and nitrate-N, but also for lime (as CaO) and phosphorus (as P_2O_5). Such figures as 40 and 103 parts per million of total nitrogen, 103 and 31 p.p.m. of CaO and 13 and 4 p.p.m. of P_2O_5 were obtained.

Fixation power of cellulose

Here then is an indication that cellulosic forms of organic matter can by simple physico-chemical processes ' fix ' from the air not only nitrogen but other nutrients.

In consequence, Ingham suggested that a tree's foliage, itself largely composed of cellulosic matter, acts as a collecting agent for nutrients. The leaves absorb plant foods, rain washes them out at intervals, and the enriched rain falls on to the soil below. To test this further, Ingham washed bunches of real leaves on a non-leguminous tree with ammonia-free distilled water, and also placed ' artificial ' leaves made from filter paper on the same tree. The accumulations of absorbed nutrients were measured weekly for both the real and the paper leaves. The real leaves absorbed per week (average of ten successive weekly measurements) 17, 41 and 3.3 p.p.m. of N, CaO and P_2O_5; the paper leaves 24, 18 and 1.7 p.p.m. respectively. In another experiment he compared the nutrient contents of rainfall

collected in the open and that dripping down from a tree in leaf. The figures were as follows:

	Rain	*Drip from tree*	
	p.p.m.	p.p.m.	*lb./acre/annum*
Ammonia-N	0.86	2.6	28.6
Nitrate-N ..	0.10	0.1	1.1
CaO ..	8.70	30.7	338.0
P_2O_5 ..	0.34	2.0	22.0

The figures are the average of monthly collections and determinations carried out during one year at a site on the sea coast of Natal, with a rainfall of 49 in.

Ingham points out that these amounts in lb./acre/annum are enough to meet the annual needs for the growth of forest trees. If the amounts seem surprisingly large, it is necessary to realise that the surface area of foliage is very much greater than the soil surface area upon which the total rain drip falls.

Discussion

It must be admitted that, without these test measurements, this thesis would be difficult to accept. The air, except for carbon dioxide and bacterially-fixed nitrogen, has long been regarded as only a small-scale direct supplier of nutrients, and the concept that lime and phosphate are air-derived is startling. Nevertheless, definite figures for absorption have been obtained. Ingham offers the explanation that these nutrients exist as aerosols, minutely small dust particles which do not settle and which, by virtue of their smallness (10^{-5} to 10^{-7} cm. diameter), must be considered to be water-soluble. Though the amounts of aerosol nutrients are very small, expressible only as parts per million, the air is constantly moving and huge volumes contact growing plants and cellulosic matter on the soil surface every 24 hours. Colloidal cellulose can accordingly be regarded as a cumulative absorbing agent for these ' inconsiderable trifles ' of the atmosphere.

The role of azotobacter

Ingham suggests that this process gives a more satisfactory explanation of unassisted growth than the commonly accepted explanations of bacterial nitrogen fixation. He disputes the role of azotobacter in the soil as an effective agent for this, pointing out that laboratory studies show that the presence of as little as 10 p.p.m. of ammonia or nitrate nitrogen inhibit fixation by these organisms while, for every lb. of nitrogen fixed, 100 lb. of carbohydrate are destroyed. This, he contends, must limit the work of azotobacter in soils to such an extent that their actual contribution of nitrogen is very minute. Yet it is necessary to explain the continued cropping of unmanured plots in long-term experiments, the constantly produced vegetation of veldts and prairies, and the far-from-small annual increases in growth of forests. Ingham's absorption mechanism not only accounts for the nitrogen supply but also for some of the mineral plant-food supply.

Conclusions

To some extent this thesis is a revival of Liebig's original view that nitrogen is supplied from the air, a view long considered disproved by the early work at Rothamsted of Lawes and Gilbert. The implications are therefore considerable and far-reaching and it seems urgently necessary that workers at various centres should carry out similar experiments. Clearly, the absorption of nutrients by cellulose and foliage must first be established as a general phenomenon. It may be that the atmosphere is a variable source of nutrients and that different results may be obtained (*a*) near coasts, (*b*) near industrial centres, and (*c*) in inland areas remote from heavily populated centres. Other experiments to test the validity of the general hypothesis could no doubt be devised. It should not be impossible, for example, to isolate a surface mulch so that all downward-moving supplies of nutrients are collected and measured over a period; if the hypothesis is correct the amounts should be greater than those indicated by ' before and after ' determinations of the nutrient content of the material while, by increasing the surface exposure of the mulch during such tests, this ' extra ' supply of nutrients should also be increased.

Nitrogen absorption by foliage

Ingham's experiment probably underassessed the absorptive capacities of foliage. Recent work in America has shown that dilute solutions of urea can be directly assimilated through the leaves,[2] and the nutrients in the rain drip or ' run-off ' from foliage may not represent the total absorption; some may have been directly taken through the foliage into the tree's system. The relatively small phosphate absorption which Ingham has measured may be exceptionally effective for this reason; for these small amounts ' fixed ' by foliage and then to some extent directly assimilated *without* passing through the soil and suffering the usual losses of soil fixation (which are likely to be high if soluble phosphate ions must pass downwards for some depth before reaching tree roots) will be more adequate than the actual figures suggest. It is worth noting that British research on the nutrient needs of fruit trees has led to the conclusion that phosphate deficiencies are exceedingly rare.[3] This new idea of Ingham seems to offer a more digestible explanation than the conventional view that the deep and ramified root system of a tree can extract phosphate from sub-soils.

Tropical soils

Cellulosic absorption of nitrogen from the air might also explain the high nitrogen and humus contents of tropical soils. It has been suggested that organic matter accumulates in such soils because the microbial population is inactive, but recent experiments have shown that similar leaves placed in natural forest soils decompose more quickly in tropical than in temperate conditions.[4] This indicates that low rather than high nitrogen and humus contents should be found in such soils. Jenny, was driven to the following conclusion: ' In searching for an explanation of the high nitrogen content of the tropical profiles it would be fallacious to point to the large annual additions of nitrogen as litter fall. These nitrogen additions cannot be considered real gains. Whereas the carbon in the trees is assimilated from the atmosphere, the nitrogen in the leaves is derived from the soil itself, *unless the leaves fix atmospheric nitrogen.*' (My italics.) 'A different approach must be sought for evaluating the source of soil nitrogen.' In pursuing that different approach, Jenny could only suggest a high addition of nitrogen in rainfall and high fixation by bacterial agencies, with principal emphasis upon the contribution of leguminous trees; Ingham's new conception of simple physico-chemical fixation by foliage may resolve this dilemma very simply; the attempt to resolve it with older ideas is much less convincing.

It should not be supposed that the necessity to use fertilisers for high cropping is in any way questioned by Ingham's experiments and deductions. Fertilisers are only supplements to natural supplies of nutrients. Further emphasis, if indeed any was required, is perhaps laid upon the importance of organic matter in top-soils; as a practical implication, sheet or surface placing of composts or organic matter may be more beneficial than ploughing in or digging in such material.

(Part II of this article will appear in the June issue)

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[2]Anon.: *Discovery*, 1950, **11**, 6, pp. 173-174.
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[4]H. Jenny: *Soil Science*, 1950, **69**, 1, pp. 63-70.

How Dependable are Disease-Resistant Varieties?

IN recent months considerable publicity has been given to serious outbreaks of stem rust which occurred in part of the spring wheat belt of the North American continent during the past summer. This has occasioned particular alarm because the varieties largely grown in the affected area are resistant varieties of common wheat, durum wheat and oats developed after many years of effort on the part of agricultural scientists. These have remained free or nearly so from rust for a period of years until now. Their failure in 1950 has raised many questions, the following being among those most commonly asked. Why did these varieties become susceptible last year? Will they remain susceptible this year and in years to come? What dependence can we place on disease-resistant varieties of plants in general? Are disease-resistant varieties of sufficient value to warrant the expense of producing them? What shall our course be in the future in regard to the development and use of disease-resistant varieties of crop plants?

Reasons for failures

Varieties of common and durum wheats possessing high degrees of resistance to stem rust became heavily rusted in Minnesota and North Dakota, particularly in the Red River Valley because of the widespread occurrence there in 1950 of a highly virulent race of the rust fungus. This race, namely 15B, can attack the resistant varieties now being grown in the area affected and in adjacent parts of western Canada. The varieties have not changed. They simply have encountered a more formidable enemy than those they have hitherto met. The late season also gave another advantage to the enemy in providing a long period for its multiplication and spread. For similar reason, stem rust-resistant oats growing in the same area succumbed to the disease due to the prevalence there of a race of the fungus to which they are susceptible, namely race 7.

There is good reason to expect that the varieties of wheat and oats which failed to resist stem rust last year will do so again if races 15B and 7 become prevalent and weather conditions favour their development. Much depends on how far the summer red spores of these virulent races of the rust fungus were distributed last year and how they become disseminated by the wind this year and in subsequent years. If they have reached warmer climes to the south and are blown northward again further damage may be experienced in the spring wheat belt.

Dependability of disease resistance

The failure of resistant varieties of wheat and oats to combat the stem rust fungus successfully in 1950 raises the question of the dependability of disease-resistant plants in general. Can we depend on the resistance of varieties to enemies other than the stem rust fungus to be maintained, for example resistance to leaf rust fungi, to smut fungi, to wilt fungi, to bacteria and to viruses? In general we cannot be certain that resistance to any of these agencies will stand up indefinitely, largely because these enemies are subject to change through hybridisation, mutation or both. By such means new races may arise which may attack varieties formerly resistant. Another possibility—and a real one—is that new strains may be introduced from the outside, even from other countries. It should also be realised that resistance to one enemy does not necessarily mean resistance to another. Hence a resistant variety may ward off one enemy but go down to defeat if another enemy against which it can put up little or no defence appears on the scene.

Value of disease-resistant varieties

There is no doubt but that resistant varieties have paid their way and there is every likelihood that they will continue to do so. They provide a cheap, convenient and effective means of preventing plant disease, one which has saved many countries from tremendous losses and which has contributed greatly to the welfare of people the world over. Even though a resistant variety stood up for but one year the cost of its production might well be justified in a valuable crop such as wheat. Most resistant varieties so far distributed have continued to be useful over a much longer period, for example, stem rust resistant varieties of wheat in Canada and the United States and curly top resistant sugar beets in the United States.

There is little doubt that we should continue on the same path as we have followed but with perhaps a clearer realisation of the necessity of continued and persistent effort.

(From information supplied by Department of Extension of the University of Alberta.)

Drying Grades — Voluntary Scheme

A new voluntary grading scheme for dried green crops has been published by the Marketing Division of the Ministry of Agriculture and has been in operation since March, the commencing month of the drying season. The recommended grades have been defined by an Advisory Committee, set up in July last year, representative of all sections of the green crop drying industry, including driers, users, chemists, research institutions and departments interested.

All manufacturers of dried green crops have been invited by the Ministry to market their products in conformity with the 'Recommended' grades and comment on their practicability after trial use. A list of these manufacturers will be published by the Ministry on May 1.

For the purpose of a trial period in 1951, three classifications have been agreed, *viz.* dried grass, dried lucerne and other dried crops (*e.g.* sugar-beet tops, kale, rape, etc.). Each of these three classifications has been subdivided into quality groups based on the crude protein content and utilisation value. The quality definitions include requirements relating to a minimum carotene content, a moisture limit of not more than 10% at the time of manufacture, the exclusion of defective, heat-damaged materials and extraneous matter. Provision has been made for a sampling procedure and control to maintain the quality standards of the national grades.

Four standard-quality grades are prescribed for dried grass. A fifth grade (of 10 to 13% crude protein) designed 'dried grass (maintenance quality)' must be labelled as such. A table showing the grades is given below.

Copies of the publications, describing in detail the new voluntary grading scheme (Marketing Leaflet No. 40), are obtainable free from the Marketing Division, Ministry of Agriculture and Fisheries, 36/38 Chester Terrace, Regent's Park, London, N.W.1.

Grade	*Dried grass and grass and legumes mixtures* %	*Dried lucerne and other pure legumes* %	*Dried green fodder crops* %
'Super'	19 and over	19 and over	19 and over
No. 1	17 to under 19	17 to under 19	17 to under 19
No. 2	15 to under 17	15 to under 17	15 to under 17
No. 3	13 to under 15	—	13 to under 15
Maintenance quality	10 to under 13	13 to under 15	—

(Crude protein calculated on a 10% moisture basis)

FARM MACHINERY

I.B.A.E. Membership Reaches 1,000

The election of the 1,000th member of the Institution of British Agricultural Engineers has just been announced from the Institution's new offices at 24 Portland Place, London, W.1. Commenting on the growth of the Institution, the President Mr. C. B. Chartres, said that membership had more than doubled during the past three years. ' It is clear that agricultural engineers are becoming increasingly aware of the importance of their role in the development of the national economy. Mechanisation has been a major factor of British agriculture's splendid efforts of the past ten years. Now the industry is faced with demands for yet further production coupled with a slow decline in man power. In these circumstances higher efficiency in machines and plant is a first essential.

' The open meetings of the I.B.A.E. act as a clearing house for information on many of the complex problems that are inseparable from agricultural engineering if only because of the many inconstant factors of soil, weather and crop. A strong and healthy Institution has a vital part to play in stepping up efficiency in farm machinery, and I view the gratifying growth in membership as a sign that engineers realise this. A big step forward has been taken by the Institution in drawing up a suitable syllabus of study and setting standards for a new National Diploma in Agricultural Engineering. The introduction of this diploma has been approved and the Examination Board is arranging to hold the first examination late in 1951.'

New Farmall Super-A Catalogue

International Harvester Export Company has released a new 24-page colour catalogue on the Farmall Super-A tractor. This four-cylinder machine is primarily designed as the power unit for the mixed farm of up to 80 acres; maximum drawbar horse power is 17.35. The catalogue covers the Super-A's main features as well as its line of ' touch-control ' implements.

Fertosan, Ltd.

We are informed that Mr. A. D. Roberts-Powell has been appointed Sales Manager of Fertosan, Ltd., Wolverhampton, manufacturers of ' Fertosan ' bacterial compost maker and ' Fertosan ' poultry land cleanser. He will be in attendance on the Company's stand at the various agricultural shows this year.

6-18ft. Range Elevator

A new 24 ft. long elevator capable of lifting sacks or bales to a maximum height of 18 ft. and a minimum of 6 ft. is now being manufactured by the Wolseley Sheep Shearing Machine Co. This machine, Model ' 18,' is the biggest elevator to be made by Wolseley and joins the other two models, ' 9 ' and ' 12.'

It has an 18 in. wide bed of 1/16 in. thick steel, chain agitated track and prefabricated rolled steel frame. The elevator rests on two 16 in. x 4 in. pneumatic tyres and can be raised or lowered by hand-powered winches. It is powered by a 1½ h.p. air-cooled petrol engine. Without the petrol engine the price is £160.

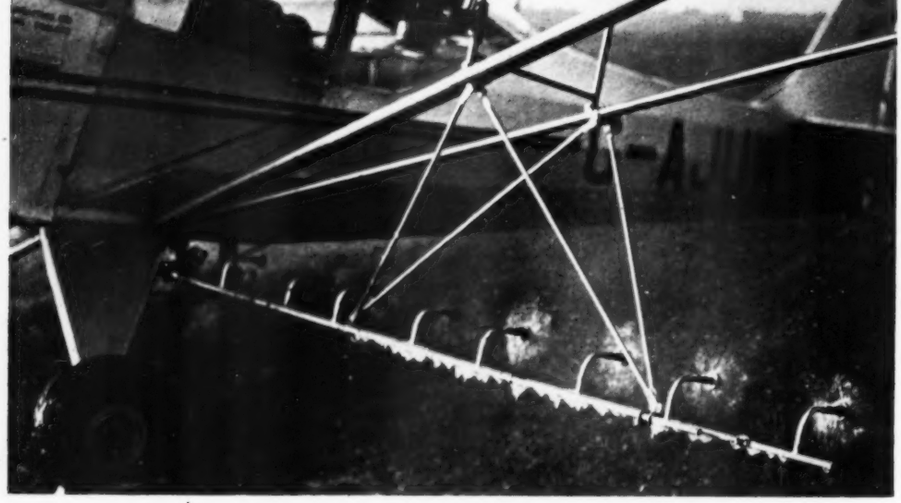
The Wolseley Co. have entered a new apparatus called the Radio Ferret for the R.A.S.E. Silver Medal Competition this year. This device makes use of radio detection in locating a rabbit and ferret underground. The principal is that a harness is fitted to the ferret instead of the normal collar, and to this harness is fitted a very small coil. This coil is connected by means of a flexible wire which is used instead of the ordinary line to the ferret, and an electrical signal is transmitted to this coil by means of a vibrator worked off a small dry battery. The pick-up unit consists of a portable combined aerial and receiving set and a pair of headphones, and when it is required to find the ferret the signal is switched up and it is claimed possible to locate it within 2 in. The price of this apparatus will be £17.

The Wolseley elevator model ' 18 ' at high elevation

The Massey-Harris No. 726 combine harvester in Argentina. The machine has been found suitable for large-scale operations in Latin-America

Aerial Spraying Successes in the Sudan

The Auster Aiglet aircraft in flight demonstrating low-altitude spraying technique



Testing the operation of the spray bar on the ground

A demonstration of aerial spraying by Auster aircraft was recently given at Boston in Lincolnshire by Messrs. Aerial Spraying Contractors, Ltd., in conjunction with Shell Chemicals, Ltd. The aircraft used for the demonstration were those that had been flown to the Sudan last year and sprayed 17,000 acres of cotton against the cotton jassid (*Empoasca Libyca*).

The spraying equipment fitted in each aircraft consists of a retractable windmill, driving a pump connected to the spray tank, which has a capacity of 48 gal. The spray bar is carried beneath the wings of the aircraft, a high-wing monoplane. Adjustment of the spray nozzle can regulate the size of spray particle.

The Sudan operations took place between October 1 and November 7, 1950, during which time a total of 300 hours was flown. Some of this time was taken up by test flying, equipment checking and communications, and an average of almost 70 acres per spraying hour was achieved. The work was carried out 100 miles south of Khartoum on both sides of the White Nile on plots varying from 30 acres to 3,000 acres. These plots were made up of fields varying in size from 5 acres to 200 acres, the average being about 75 acres.

The maximum output was 280 acres in 50 minutes, operating from a landing strip adjacent to the field; in this instance the turn-round from 'wheels on' to 'wheels off' averaging 1 min. 30 sec. The deposit per acre varied from 2 to 4 gal. of liquid, and the height from which it was applied varied from 6 ft. to 15 ft. depending on crop and climatic factors. Spraying began at first light because experience had shown that conditions were most favourable in the early morning.

The cost of aerial spraying on a per-acre basis, compared with doing the job with a land machine depends, obviously, on the area to be sprayed. Generally speaking it may be said that for areas of up to 10 acres the price would be from 2s. 6d. to 10s. per acre more expensive than ground spraying, from 100 to 200 acres the job would be done at about the same price and in excess of this figure it would be cheaper than ground spraying.

It is considered by the firm that aerial spraying has its place in the English sphere of operations as a supplement to rather than as a substitute for ground spraying.

Professor Hardy in Ceylon

Professor E. A. Hardy, Professor of Agricultural Engineering at Saskatoon University, Saskatchewan, was entertained at a luncheon early in March by the British Agricultural Machinery Manufacturers Export Association (B.A.M.M.E.X.).

Professor Hardy was en route for Ceylon to advise the Government there on the question of dry farming. This has been arranged by FAO, and he was glad to make contact with the British manufacturers before his departure and will arrange to see them on his return. Although he was only in London for 48 hours, quite a large party representing the trade was present to meet him.

Drake & Fletcher Ltd.

On April 17 the Rt. Hon. the Lord Cornwallis, K.B.E., M.C., J.P., opened a new premises in the Broadway, Maidstone, Kent, erected by Messrs Drake and Fletcher Ltd., the well-known manufacturers of spraying equipment.

WORLD CROP REPORTS

AUSTRALIA

Wheat statistics. From our Australian correspondent the following figures have come in. The Commonwealth statistician has revealed the final figures for the Australian wheat harvest as 183,400,000 bushels—16.7% below the 1947-48 record. State production was: Victoria, 51,000,000 bushels; Western Australia, 48,500,000 bushels; New South Wales, 44,000,000 bushels; South Australia, 30,800,000 bushels; Queensland, 9,000,000 bushels; Tasmania, 110,000 bushels, and Capital Territory, 35,000 bushels. On March 6, Australian wheat growers received £17,654,833, of which £16,420,344 was refund of export charges tax for the 1947-48 season.

During the period August 1, 1949, to July 7, 1950, Australia sold 80,386,000 bushels of wheat to countries which are signatories to the International Wheat Agreement (commitment was 80,799,418 bushels). Sales under the agreement (in bushels, but including flour) were: United Kingdom, 21,001,000; Holland, 2,639,000; Norway and Sweden, 1,521,000; Portugal, 55,000; the Middle East (excluding Egypt), 401,000; Egypt, 6,864,000; India 38,274,000; Ceylon, 4,409,000; Asiatic countries (excluding India and Ceylon), 23,000; New Zealand, 2,806,000; Peru, 317,000. Sales on the free market were: Yugoslavia, 329,000; Spain, 2,240,000; Egypt, 1,833,000; Finland, 1,344,000; Middle East and Mediterranean, 646,000; African countries, 127,000; Ceylon, 1,852,000; Malaya, 250,000; China, 2,729,000; Japan, 7,766,000; Formosa, 630,000; other Asiatic countries, 727,000; Peru, 933,000; New Zealand, 1,000,000; Pacific Islands (for ships' stores), 1,024,000.

Rice in Western Australia? It is probable that rice may be grown on a large scale in the near future in the Kimberleys of Western Australia. It is thought that normal rainfall and seasonal flooding would obviate the necessity for expensive irrigation schemes. It is already known that good quality rice can be grown with success in Australia, but today almost all Australian rice is produced in New South Wales. Before Australian domestic demand could be satisfied at least 100,000 tons a year would have to be produced against the current 70,000. (Present price for milled rice is £45 a ton.)

Lower apple yields. Apple yields in New South Wales and South Australia have suffered heavily from unfavourable growing season conditions and the marketable crop will probably be well below last year's, according to Agriculture Department estimates.

In **New South Wales** the 1951 crop is expected to be the lightest for years, with current estimates of 850,000 loose bushels (equivalent to approximately 680,000 packed bushels) as against 1,296,000 bushels in 1950.

Below-average crops in **South Australia** so far point to a disappointing season. No statistical estimates are yet available.

The New South Wales **pear crop** has also been hit. A total yield this season of 380,000 loose bushels (about 300,000 packed) is forecast. The 1950 crop totalled 409,000 bushels.

SOUTH AFRICA

Weather hinders Transvaal tobacco. Our South African correspondent reports that unfavourable weather has been beating down on the tobacco crops in the Transvaal, and consequently this year's crop may be half the size of last year's. Many experiments with the new orinoco tobacco, grown for the first time in South Africa, have also been ruined. The tobacco farmers had decided to grow orinoco this year as well as their usual ammarello type to reduce the amount of orinoco needed from Rhodesia. It was hoped that South Africa could grow enough orinoco, if the experiments were successful, to export to Britain and other parts of the world where there is a ready market for this type of tobacco. But Transvaal weather has in no way aided tobacco growing in the past few months. Most Transvaal tobacco farmers have a section of young plants still growing on their lands not yet affected by the bad weather. Although the 'deadline' for planting tobacco was January 15—the plants must be fully grown before winter—many farmers took a chance and re-ploughed and re-planted to try to make up, in some way, for recent losses.

Record chicory crop expected. A big part of the record chicory crop in the Alexandria area of the Cape may be lost because farmers lack the facilities or labour for drying it. The existing number of drying kilns is not sufficient to handle the crop and the cement shortage has held up the building of others.

The Union's crop this year has been estimated officially at about 13,000,000 lb., which is six times as big as the crop last year when it was necessary to import chicory.

U.S.A.

1950 rice exports decreased. Exports of United States rice during 1950 totalled 10,851,000 bags (100 lb.), a decline of 5% from the record of 11,370,000 bags in the preceding year. Consignments to Cuba of 6,766,000 bags were the largest on record, representing more than 60% of total exports. Shipments of 1,521,000 bags to Japan, the market next in importance, made up 14% of the total deliveries.

Rice exports to European countries, however, declined 227,000 bags, or 25%, from 1949. Of the 673,000 bags exported, 307,000 were shipped to Greece; 217,000 to Belgium and Luxembourg; 120,000 to Switzerland, and 29,000 to other European countries. Exports to Canada of 592,000 bags of rough rice (385,000 bags in terms of milled) and 65,000 bags of milled rice also were smaller than 1949 exports of 744,000 bags of rough rice (484,000 milled) and 21,000 bags of milled rice.

The total 1950 rice exports by classes of 10,851,000 bags were comprised of the following (1,000 bags): Rice, milled, containing more than 25% whole kernels, 9,627; rice, milled, containing not more than 25% whole kernels, 822; rough rice, 619 (402 in terms of milled converted at 65%).

BRITISH HONDURAS

Banana project. The banana project in the Stann Creek Valley is progressing favourably and 1,000 acres have been planted out with the Lacatan variety. The first shipment (approximately 25,000 stems) will be ready in June 1951, and thereafter it is hoped to increase shipments to 40,000 stems per month this season, doubling the quantity next year.

ITALY

Increased exports of produce. Our Italian correspondent reports that during 1950 exports of most of Italy's agricultural produce showed an increase over 1949 with the exception of fresh fruit, hemp, flax and jute. Figures for the various crops are as follows:

	1949 (tons)	1950 (tons)
Rice	158,412	224,234
Potatoes	63,828	93,193
Fresh vegetables	198,907	251,207
Citrus fruit	355,597	367,691
Dried fruit	63,452	85,310
Wines and vermouth (hectolitres)	620,193	929,605
Unmanufactured tobacco	7,005	9,595
Oil seeds and fruit	22,618	34,812
Fresh flowers and living plants	10,916	30,978
Preserved fruit and vegetables	42,013	117,962
Fresh fruit	334,085	269,227
Hemp, flax and jute	37,128	34,849

INDIA

First groundnut estimate. According to the Directorate of Economics and Statistics, Ministry of Agriculture, the All-India First Estimate of the area under groundnuts for 1950-51 is 4,445,000 acres.

The information given in this estimate relates to the period generally up to the middle of July 1950 and to early varieties, which cover only about 30% of the area which may ultimately be sown under groundnut during 1950-51.

Expansion of tobacco industry. The tobacco industry in India has shown marked expansion in recent years and the country is the world's third largest tobacco area. Output in the country rose from 725,000,000 lb. in 1948-49 to 800,000,000 lb. in 1949-50. There has also been a steady increase in India's tobacco exports. Shipments in the first four months of 1950-51 amounted to 26,000,000 lb. representing an increase of 6,000,000 lb. over the figures of the corresponding period last year. Exports during April 1949 to March 1950 totalled 71,000,000 lb. The principal buyers are the U.K., Sweden, Belgium, Aden, Egypt and Ceylon. The important varieties of tobacco exported are flue-cured Virginia, White Burely and sun-cured Natu, an indigenous variety.

The main producing areas are Madras, Bombay, Uttar Pradesh and Bihar.

Sesamum. According to the Directorate of Economics and Statistics, Ministry of Agriculture, the All-India Second Estimate of Sesamum, 1950-51, puts the current year's acreage at 3,380,000 as against last year's adjusted corresponding figure of 3,376,000 acres.

An appreciable increase over last year's acreage has been reported from Saurashtra, mainly as a result of favourable climatic conditions at sowing time. On the other hand, Madras has recorded a decrease in acreage and attributed this to the paucity of rains in certain parts of the State at the time of sowing.

GOLD COAST

Palm kernel and copra prices raised. Producer prices of palm kernels and copra in the Gold Coast were increased from January 1 this year, according to an announcement of the Agricultural Produce Marketing Board. The palm kernel price was increased from 11s. to 16s. a load. In addition, the Board will pay a bonus of £1 a long ton to licensed buying agents for all parcels of palm kernels offered for export when the content of faulty kernels is 5% or less. The allowable admixture is 10% at present, but it is expected to be reduced to 5% in about a year's time.

ENGLAND AND WALES

Winter corn. The area sown with **wheat** by December 4 last was returned as 1,530,000 acres, a reduction of 333,000 acres (18%) compared with a year ago, but only 50,000 acres less than in December 1948. The area returned under **rye** at 53,000 acres was 14,000 acres smaller on the year.

EAST AFRICA

Increased tea production. British East Africa's 1950 tea production is now estimated at 19,100,000 lb. compared with only 16,700,000 lb. in 1949, according to a report in *Foreign Crops and Markets*. By 1954 it is expected that tea production in British East Africa will approximate 25,000,000 lb. annually.

Total acreage of mature tea in British East Africa increased from 32,722 in 1949 to 34,375 in 1950. Acreage and production by territories for 1949 and 1950 are shown in the table below.

There was a sharp increase in capital investments in the British East African tea industry during 1950. Significant reasons were heavy world demand for tea, high export prices, a generally adequate supply of cheap labour in British East Africa and low taxation rates. During the year large supplies of locally developed seed became available and nurseries on the large estates were well stocked with seedlings. At Kericho, experiments in vegetative propagation were carried on by the East African Tea Research Institute, a statutory experimental centre operated from funds provided by a production tax.

Tea consumption in British East Africa increased from 7,600,000 lb. in 1949 to 9,400,000 in 1950. Exports during the first nine months of 1950 totalled 9,300,000 lb. compared with exports of 9,200,000 lb. for the entire 1949 calendar year. This increase is attributed to larger production and processing capacity and the unloading of a large carry-over from 1949. Principal destinations during the first nine months of 1950 were the Anglo-Egyptian Sudan (2,325,000 lb.), Canada (1,845,000 lb.) and the United States (1,546,000 lb.).

ARGENTINA

Maize estimate. The Argentine maize crop is currently expected to yield about 4,000,000 tons, according to private estimates. The severe drought last year reduced the 1949/50 yield to 844,000 tons, the lowest in recent history, while in three years during the early 1940's the yield was as high as 10,200,000, 9,000,000 and 8,700,000 tons. Domestic consumption of maize this year is estimated to be around 3,000,000 tons, leaving about 1,000,000 for export.

1,000,000 ton sunflower crop. This year's sunflower crop is privately estimated at about 1,000,000 tons, compared with 712,000 tons in 1949/50, an average of 927,000 tons for the crop years 1945/46 to 1948/49 and nearly 1,500,000 tons in the best years. It is thought unlikely that there will be much grain up to the 59% standard of kernel.

Harvesting of maize and sunflower should begin towards the end of April.

WEST INDIES

Sugar estimates. Estimated production of sugar for the quota year ending August 31, 1951, as given by the West India Committee Circular, is as follows:

	Tons
Barbados	174,000
Jamaica	281,280
Leeward Islands:	
Antigua	26,750
St. Kitts	44,000
Trinidad and Tobago	162,500
Windward Islands:	
St. Lucia	10,300
St. Vincent	2,700
British Guiana	189,401
British Honduras	Nil
Total	890,931

EGYPT

1952-53 cotton estimate. The estimated figure for production of cotton was given in *World Crop Reports* (March issue) as 852,000 metric tons from 819,000 hectares; this refers to cotton seed production. Production of cotton lint from the 819,000 hectares is expected to be around 482,000 tons.

TEA

British East African Acreage and Production by Territories, 1949 and 1950

Territory	1949		1950	
	Acreage	Production	Acreage	Production
	acres	1,000 lb.	acres	1,000 lb.
Kenya	17,765	11,900	18,000	14,000
Tanganyika	8,800	1,452	9,375	1,595
Uganda	6,157	3,360	7,000	3,500
Total	32,722	16,712	34,375	19,095

Source: Kenya, Tanganyika and Uganda Departments of Agriculture.